# LOWER PAJARO RIVER ENHANCEMENT PLAN

FOR

GREEN VALLEY, CASSERLY, HUGHES,
TYNAN, COWARD AND THOMPSON CREEKS
SANTA CRUZ COUNTY, CALIFORNIA

**Prepared For:**

Santa Cruz County Resource Conservation District
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**DECEMBER 2002**

FINAL REPORT

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# EXECUTIVE SUMMARY

## ES 1. INTRODUCTION

The Pajaro River Watershed is one of the largest riverine systems entering the Monterey Bay and drains an area of approximately 1,300 square miles of land in Central California.

Historical and current land use practices continue to impact water quality in the main areas of the watershed. The predominant land use practices in the Lower Pajaro River and its tributaries include irrigated croplands, rangelands, urbanization and rural residential development. Each of these land use practices can potentially contribute a variety of pollutants such as sediments, nutrients, pesticides, pathogens, oil and grease to waterways in the watershed.

Physical habitat quality assessments completed by the California Department of Fish and Game (CDFG) in 1998 indicate that sediment deposition is a significant water quality problem in the Pajaro River watershed. This is exemplified in the lower Pajaro River where high accumulation of sediment has covered larger gravel bottom substrates, which are important for salmonid (steelhead) spawning and rearing habitat. Additional studies conducted by the CDFG have detected elevated levels of DDT and other residual persistent pesticides that continue to enter the Pajaro River from eroding soils from adjacent lands. The levels of residual pesticides detected at times, typically during storm events, can exceed water quality objectives to protect aquatic life. The Pajaro River and several tributary streams are considered, by both state and federal agencies, to be water quality impaired due to sedimentation.

Excessive erosion and sedimentation is also resulting in loss of agricultural soils, roads, riparian and stream habitat. Many natural and human induced factors contribute to, or exacerbate erosion and sedimentation problems in the lower Pajaro River watershed. Natural and generally uncontrollable and significant sediment sources include landslides and slumps, which are common along the San Andreas Fault Zone in the upper watershed lands in the Santa Cruz Mountains. Increased runoff from recently converted croplands from orchards and rangeland directed to aged, failing and poorly maintained infrastructure (drainage ditches, culverts and roads) is causing severe erosion problems in many locations throughout the watershed. Stream bank instability due to removal and/or loss of riparian vegetation in the low watershed areas is also resulting in acute erosion and sedimentation problems in the watershed.

The Santa Cruz County Resource Conservation District (SCCRCD) has undertaken this enhancement planning study to assess erosion and sedimentation problems in several tributary watersheds in the Lower Pajaro River watershed. The tributary streams studied are characteristic of Central Californian coastal streams located in agricultural valleys. The development of the enhancement plan is being supported by a grant jointly funded by the California Coastal Conservancy and the California Regional Water Quality Control Board.

A key goal of this enhancement plan is to work in cooperation with landowners, land managers, and agency staff to assess historical and existing conditions in order to determine principal physical factors causing significant erosion and sedimentation problems in the areas studied. Once a baseline study is completed, enhancement strategies can be developed to address and reduce drainage and erosion problems in the study area.

Part I of the enhancement plan provides an assessment of existing conditions. Field assessments were carried out with cooperative landowners/managers, agency staff and at public access points. They were conducted on up- and lowland areas, riparian corridors and streams. Up- and lowland assessment activities focused on critical water, soil, and/or vegetation management practices or structures. The riparian and stream survey assessment portion of the study evaluated riparian vegetation, channel stability, bank conditions, and erosion and sedimentation impacts. The assessment included development of geographic information system (GIS) map layers describing land use, soil classification, and general channel characteristics (stream type, position and location). Utilizing the GIS maps and field assessment data, summary statistics were calculated for a variety of parameters including; distribution of slope classes; acreage of erosion-prone soils; and streambank erosion potential.

Part II of the study presents an enhancement plan for the study area. The objectives of the enhancement planning stage of the project was to identify and evaluate both programmatic and structural projects, which can be initiated to address long-term drainage and soil conservation practices in the area.

A variety of alternative on-farm and bank stabilization best management practices (BMP) are presented in Section 6 that can be used to stabilize sediment (source control) and to reduce erosion and the delivery of sediment from upland areas and waterways. All of the practices described are cost-effective methods designed to stabilize soil by primarily slowing runoff from the fields and by stabilizing stream and waterway banks that are experiencing excessive bank erosion. These sheet and rill erosion from bare fields and bank erosion from unstable drainage ditches and waterways are resulting in the most severe erosion and sedimentation problems in the Pajaro Valley region. Several of the recommended BMPs also provide additional benefits to the land by conserving soil, improving water infiltration and groundwater recharge, improving soil fertility, reducing costs for ongoing maintenance of infrastructure (access roads and drainage systems), reducing land loss, enhancing habitat and improving water quality. Practices described are well established techniques, recommended by local, state and federal resource conservation agencies, including the Santa Cruz County Resource Conservation District and the Natural Resource Conservation Service.

Three demonstration projects are presented in Section 7. The first two projects will involve stream bank stabilization measures and are located in the Green Valley and Coward Creek watersheds. Each project will be constructed utilizing different biotechnical bank stabilization methods to repair highly eroded banks. The projects will illustrate how the use and integration of vegetation and structural materials can be employed to stabilize and enhance steam and riparian conditions in the Pajaro Valley. The third project presents alternative conceptual wetland and stream restoration plans for a 50-acre site in the upper College Lake basin. The project will potentially restore between 18 to 30 acres of freshwater wetlands and approximately 2,000 lineal feet of stream channel. This project presents a unique opportunity to restore a relatively large tract of open space as a multi-use facility that would restore wetland and riparian habitat, create environmental education and recreational opportunities, and provide an alternative source of local water supply.

Each demonstration project describes the project setting, a brief problem assessment and baseline information, including topographic, hydrologic and water quality data, if available or pertinent. A conceptual restoration plan is presented that identifies the principal goals and design criteria for the proposed enhancement project.

A variety of management or programmatic issues and potential constraints can affect the implementation of enhancement projects throughout the Pajaro Valley. Project permitting can be a cumbersome and expensive process, which can be an obstacle or disincentive for private landowners and public agencies to move forward with projects located in potentially sensitive habitat areas. Limited technical and financial resources have and will continue to affect project implementation. A lack of planning, coordination and collaboration between private and public parties has also caused project delays and/or suspensions. Little post project monitoring or evaluation has been carried out so that limited benefit-cost information is available for many best management practices in use or proposed in this plan. Section 8 presents a series of recommended programmatic activities, including the need for drainage master planning, technical training and evaluation projects, and additional demonstration projects.

Section 9 presents proposed planning and implementation activities that should be undertaken to implement the enhancement plan. Preliminary budgets and timelines have been outlined for each proposed activity.

**ES 1.1.Watershed Description**

The project area is located in the Lower Pajaro River watershed in the Pajaro Valley. Watershed assessment activities were conducted in several tributary watersheds including Green Valley, Casserly, Hughes, Tynan, Coward and Thompson Creek watersheds. All of these streams originate in the Santa Cruz Mountains, drain to the Pajaro River and are located in Santa Cruz County, California. The project area encompasses approximately 23,275 acres (15 square miles).

The project area is located within the San Andreas Fault Zone, which is a very dynamic tectonic region. The major faults in the Santa Cruz Mountains have strongly influenced the physiography and drainage, both by relative movements of the blocks between them or by folds produced in them. The sculpturing of the surrounding mountain ranges has been strongly affected by the zones of weakness resulting from the faulting and folding.

All of the watersheds originate in the Santa Cruz Mountains where streams are very steep, deeply entrenched and confined with cascading reaches. The watersheds are set in areas of high relief and the streambeds are both erosive and bedrock form. A majority of the streams have relatively small watersheds, which have very short lag times between precipitation events and high peak runoffs and limited seasonal baseflow. Longitudinal stream gradients range from 10 to 30 feet per mile in alluvial valley reaches and as much as 600 feet per mile in the headwaters. Leaving the mountainous regions, the streams drain into the alluvial valley floor where many of the stream courses have been modified and channelized.

Land use activities in each watershed are primarily dictated by topography, geology and climate conditions. Principal land uses in the upper watershed areas include rangelands, timberlands and rural residential developments. Croplands, orchards, nurseries and the urbanized area of the City of Watsonville are the predominant land uses in the valley floor.

Over the past 15 years land conversion activities from orchards to row crops has been occurring on the relatively level valley floors. Strawberry and cane- or bushberry production has increased dramatically on foot slope areas where erosion risks are generally higher. A substantial increase in rural residential development has also occurred over the past 10 years in many of the upper watershed areas, most notably in the Green Valley and Casserly Creek watersheds. Changes in land use have dramatically affected drainage, erosion and sedimentation conditions in the watershed.

### ES 1.2.Land Use

Generally, the valley floor is utilized for row crop production, agricultural accessory structures, and to a lesser degree housing. Vegetable row cropping still dominates the study region, however strawberry and cane- or bushberry production is expanding, and becoming very important in some subareas. Grazing and timber production is the dominant land use in the upland portions of the study area. The amount of land in grazing and timber harvest practice has remained relatively constant over the past several decades. However, the amount of rural residential development has increased substantially in the past decade, most notably in the Green Valley and Mt. Madonna area.

### ES 1.3.Stream System

The mountainous portion of each watershed lies in the south end of the Santa Cruz Mountains. This terrain consists of a steep, dissected landscape with shallow, erodible soils underlain by highly fractured sedimentary rock. The region also lies on top of several active fault plains, most notably the San Andreas. The active zone of faulting results in the formation of highly erodible clay soils, geologic control of drainage patterns and the presence of slumps and seeps.

Due to the presence of steep mountain fronts in close proximity to the ocean, wet, winter frontal storms are lifted up over the mountains, releasing large amounts of precipitation as the air mass is cooled. This process is known as orographic uplift and can result in intense rainfall events during the winter months on the order of several inches in the period of a few hours. This intense precipitation, combined with steep terrain and erodible soils, results in high erosion rates off the hillslopes with high potential sediment transport capacities in the stream channels. The majority of the sediment delivered from the hillslope is the result of landslides, soil slumps and debris flows that deliver an assortment of grain sizes to the channel. Since these erosion events often occur during intense storms, when streamflow is high, the delivered sediments are immediately sorted with the finer grained portion being transported to lowland areas.

The lowland areas of the Casserly and Coward Creek watersheds consist of incised channels cut into extensive alluvial deposits. The Zayante Fault Zone cuts across the study area resulting in perennial and intermittent lakes that provide hydrologic control to Casserly Creek and other small drainages (e.g. – Kelley Lake and Tynan Lake drainages).

Prior to agriculture as the dominant land use, very little runoff occurred from land adjacent to lowland stream channels. Instead the lowland stream channels conveyed water from the mountainous reaches and recharged the lower Pajaro River aquifer.

A significant change in slope occurs as the streams within the study area leave the confined mountainous areas and flow out onto the coastal plain. The result is a reduction in available stream power as the channel gradient decreases and the flow becomes wider and shallower. Sediment-laden water reaching the coastal plain is deposited, resulting in aggradation of the bed.

As agriculture began to dominate the local land use, the process of channel migration and alluvial plain development became incompatible with the needs of the farmers. The meandering channels were subsequently straightened, narrowed and confined. In many cases, the result of this action has been steepening of streambanks, channel downcutting, and loss of riparian vegetation, agricultural lands and roads.

The dominant influence on the primary channels within the study area is the general trend and zone of influence of the San Andreas Fault Complex. In the subwatersheds where the San Andreas Fault occurs in the steep, upper reaches of the stream, the channels are characterized by high sediment loads, landslide failures and bank slumping, and aggradation of downstream reaches. These conditions occur in Thompson, Coward, Tynan-Martin and College East streams. Elsewhere, the San Andreas Fault Zone runs through the middle reaches of the stream system where the hillslopes are not as steep, resulting in less sediment generation and delivery to stream channels.

Due to movement along the San Andreas, several of the larger subwatersheds (e.g. – Green Valley, Coward), have developed upland, low gradient valleys that run parallel to the fault trend. These areas can act as sediment storage sites in the event of large slumps or failures of fine-grained sediment. Poor land use practices, road building, and channelization of these upland valleys can result in loss of sediment storage function that can have a considerable impact downstream. These impacts can include increased bank erosion as the channel cuts down through the alluvial fill, reduced storage capacity and increased sedimentation in downstream reaches.

## ES 2. EXISTING CONDITIONS ASSESSMENT

The assessment of existing conditions focused on upland, stream and riparian corridor areas. The following provides a brief description of the work carried during this phase of the project.

### ES 2.1. Upland Assessment Method

The assessment of lands within the study area was facilitated by a number of concerned and interested landowners or managers within the various sub watershed areas. The focus of this assessment phase was on agricultural and rangelands and, due to time constraints, the assessment could not effectively include rural residential properties. For the most part, the accessibility and cooperation of owner/managers dictated the areas assessed. In some cases, where particularly severe or unique problems exist, additional effort was made to contact and visit with as many owner/managers in these areas as possible. An assessment form was used as a general outline to interview landowners and land managers and to collect field data (see Appendix D).

Approximately 8,750 acres (~37 percent) within the project area were covered as part of the assessment phase. Much of the assessed acreage resulted from visits to the three largest upland ranches in the region that account for approximately 6,050 acres. Each of these large ranches occupies more than one subarea. The remaining approximately 2,700 acres assessed were largely in the lowland portions of subareas where vegetable, berry, flower, nursery and apple production were the most common land use.

### ES 2.2.Stream and Riparian Corridor Survey Assessment

The stream and riparian survey assessment portion of the study included several elements aimed at depicting existing and potential future conditions within the study watersheds related to riparian vegetation, channel stability, bank conditions, and erosion and sedimentation impacts. The initial assessment included development of GIS map layers describing general channel characteristics such as stream type, position and location. Reconnaissance field surveys were conducted to collect site-specific information about riparian corridor and channel conditions.

Identified stream types within the study area included primary channels, channelized creeks, lake boundaries, permanent agricultural ditches, road ditches and seasonal agricultural ditches. An initial determination was made between agricultural and road ditches and streams. The streams category was delineated further into primary channels and channelized creeks. Channelized creeks were defined as streams that have been highly modified through relocation or straightening.

A geologic map of the region was used to differentiate stream position. Streams that occur on extensive alluvial deposits that dominate the lowland were classified as coastal plain streams. If a stream occurs on other geologic formation they were classified as mountainous.

The location attribute defines each stream within a particular subwatershed, as shown in Figure 2.4. This attribute is mainly used as a tool to group streams within a watershed context to assist discussion. Most watersheds were named for the primary stream flowing through them while other subwatersheds, such as Spring Hills and Kelley, were named according to a dominant feature occurring within the subwatershed

Streambank erosion potential was determined at accessible points on coastal plain streams. Reaches of streambank were classified into relative bank erosion potential (e.g. – very low, low, moderate, high, very high, and extreme) providing an index to compare conditions throughout the study area.

Upper watershed, mountainous stream reaches were not assessed for erosion potential due to limited stream access points and the total number of stream reaches that occur within the study area. Instead, as many streams as possible were assessed qualitatively based on landowner cooperation and available time. Notes were made regarding the general conditions of the channels, grain sizes of the bed material and problematic erosion sites.

Riparian vegetation conditions on streams within the Lower Pajaro River study area were assessed using several methods. A color aerial orthophoto (flown in June 2000) was used to review general watershed conditions and status of riparian vegetation on streams within the lower and upper watershed areas. Reconnaissance-level field visits were conducted to field check the aerial photo review and to identify predominant vegetation type.

### ES 2.3.Overview of Assessment Results

Erosion and sedimentation problems occur in all parts of the study area, however, there are a few areas where these problems are particularly acute and are due to a complexity of factors.

In general, land use the upper watershed areas have been under similar uses and management for the past century and few problem areas are present. In these areas there is little access to seasonal creeks by livestock, although there are very few areas with riparian fencing.

Bank instability, removal and/or loss of riparian vegetation are more common in the lowland areas, where many recent land use changes have and are occurring. In general there appears to be more obvious problems in areas with a greater percentage of the land areas used for row crop vegetable and berry production. The continued conversion of orchards to row crop production increases in impervious surfaces and runoff.

Additional factors, such as an increase in rural residential development, poorly coordinated maintenance of drainage infrastructure between public and private sectors, and permitting issues are common themes where significant problems exist in the study area.

**Land Use Conversion and Drainage**

In general, the drainage infrastructure (e.g. roadway ditches, agricultural ditches, and channelized creeks), in many areas are less than adequate to convey runoff given the amount of development and conversion of agricultural lands in the past two decades. As a result there are increasing problems with localized flooding and sedimentation, collapse of road shoulders, failure of drainage ditches, and increased instability of creek channels and riparian vegetation.

Over the past 15 years, the reduction of apple acreage has continued, particularly on the nearly level soils of the valley floor. These lands have most often been converted to row crop acreage that has dramatically changed the nature and volume of drainage water from these lands. While strawberry and bush berry production has increased, much of the new berry production acreage is being developed on foot slope areas on lands with slopes of greater than two percent, where erosion risks are generally higher. The change in land use from permanent orchards has perhaps had the most significant impact on drainage infrastructure and sedimentation in certain portions of the study area. Increases in rural residential development are also leading to increased surface runoff. As with agricultural drainage, most of the increased runoff from residential development may be directed to roadway ditches and/or creeks.

Generally, the study found numerous problems, primarily in the lowlands areas, related to the lack of coordinated maintenance or enhancement efforts between owner/managers and County or State departments. Another common problem, related to changes in agricultural land use, are practices and/or structures adopted by one owner/manager that have led to or have compounded ‘downstream’ problems for another owner/manager. As mentioned previously, we also have noted that recent land use changes, particularly conversion of apple orchards to cane- or strawberry production, have led to increasing localized sedimentation. In these areas we often found that pre-existing drainage infrastructure, whether private or public, was not adequate to handle either increased runoff volumes and/or velocities.

**Riparian Corridors**

A substantial percentage of lowland waterways in the study area have little or no native riparian vegetation due to plant removal by herbicide or mechanical means, or channel relocation to the edges of farm fields or property boundaries. Where riparian vegetation is absent or where native species have been replaced by shallow-rooting non-native ruderal (weedy) species, there is little protection against bank slope failure and significant erosion. Stream reaches with a mature riparian vegetation canopy and a relatively complete native or non-native understory generally have relatively intact streambanks, although stream downcutting may be occurring due to unstable conditions up or downstream.

**Streambank and Channel Conditions**

In general, the results from the stream bank and channel study suggest that most of the coastal plain stream reaches either are, or have a high potential of experiencing significant bank erosion due to the present condition of the banks. This is the result of several factors: downcutting and bank steepening due to increased runoff; narrowing of the channel to maximize agricultural production, and loss and/or removal of riparian vegetation that support the banks. Natural bank instability also exists within the project area due to the presence of fine-grained sediment that is the predominate grain-size and highly erodible. Stream reaches in that are experiencing low bank erosion are often reaches that are vegetated, aggrading (filling), have low bank height and or mild side slope angles, such as Salsipuedes or Spring Hills streams. Other streams, such as Green Valley and Casserly creeks, have intact riparian corridors but are experiencing downcutting (channel incision) and loss of bank stability in certain reaches. The result is a high potential for erosion and loss of established riparian vegetation, as the banks become undermined. This may be attributed to several factors including the lowering of the shallow groundwater, channelization, and increased runoff from upland areas.

Results for the mountainous reaches are not as easily quantifiable. Accessible survey locations were assessed for the upper watersheds of Green Valley, Casserly, Coward and Thompson Creek. The results suggest a gradient in conditions from southeast to northwest within the study area. Channels in the southeastern part of the study area and within the upper watershed of Coward Creek consist of fine-grained sediment and experience constant and extensive landsliding and slumping. Conversely, stream channels to the north in the upper Green Valley watershed consist of coarser sediment, large woody debris accumulations and less landsliding. This natural variability plays an important role in dictating the conditions of the stream channels and their impact on sediment transport, channel aggradation, bank stability and flooding in the lower reaches.

### ES 2.4.Summary of Findings

**Physical Conditions**

1. In general land use in the upper watershed areas of all the sub-areas have been under similar uses and management for the past century and few problem areas are present. In general there is little access to seasonal creeks by livestock although there are very few areas with riparian fencing.
2. Several factors throughout the study area, including conversion of agricultural lands over the past two decades to production systems that require rapid drainage (Sic. runoff) during the winter and rural residential development has overwhelmed aged and undersized drainage infrastructure. This infrastructure includes roadway ditches, agricultural ditches, culverts and channelized creeks. These factors are resulting in increased problems with localized flooding and sedimentation, loss of agricultural soils, collapse of roads, failure of drainage ditches, increased instability of creek channels and loss of riparian vegetation.
3. Minimal or no setbacks from the waterways combined with loss or removal of riparian vegetation appear to be significant contributors to downcutting and bank failure resulting in significant loss of private land and public roads.

4. Several streams and waterways have been channelized with severe bends (45 to 90 degrees) that, along with the lack of permanent vegetation, result in high bank instability, erosion, and sedimentation.
5. A substantial percentage of lowland streams in the study area have little or no native riparian vegetation due to plant removal by herbicide or mechanical means, or channel relocation to the edges of properties.
6. Stream reaches with a mature riparian vegetation canopy (trees) and a relatively complete native or non-native understory generally have relatively intact streambanks, although stream downcutting still occurs due to unstable conditions up or downstream.
7. Loss of permanent riparian vegetation, annual removal of herbaceous vegetation just prior to the rainy season, channel modifications, and minimal to no buffers are resulting in large annual sediment loads from private and publicly managed lands.
8. Where riparian vegetation is absent or where native species have been overtaken by shallow-rooting non-native weedy species, there is little protection against bank slope failure and significant erosion.
9. Stream reaches in the study area experiencing minor bank erosion are often reaches that are aggrading or banks are relatively low, well vegetated and/or mildly angled side slopes, such as Salsipuedes or Spring Hills streams.
10. Other streams, such as Green Valley and Casserly, have intact riparian corridors, but some reaches are experiencing downcutting and severe bank instability. This condition result in a high potential for erosion and loss of established riparian vegetation as the banks become undermined. This may be attributed to several factors including the increased runoff from recently developed land, lowering of the shallow groundwater, and channelization.

**Management Issues**

1. There are a limited number of landowners who have adopted best management practices to control runoff, erosion and sediment on their lands. These projects are successfully reducing sedimentation in the project area.
2. Several of the landowners that participated in the assessment phase of the project are very interested in developing long-term solutions to address drainage and erosion problems throughout the watershed. Many landowners are even willing to provide financial assistance to remedy drainage and bank stabilization problems affecting their lands.
3. Multiple lease tenants are a common occurrence in the project area, and the responsibility for the coordinated management of the drainage system(s) serving a particular property can ‘fall through the cracks’ and result in accumulation of sediment in drainage ditches. During subsequent storm events, the ditches can over top causing localized flooding, erosion of roadways and release of sediment across roads and onto adjacent properties.
4. Increased tenant farming creates pressure to maximize economic return for both the landowner and leasee. In many areas this has pushed growers to farm close to the edge of the fields, minimizing setbacks from drainage courses. Double and triple cropping, along with berry production practices leave many fields bare during the winter months. These practices are contributing to erosion and sedimentation problems in downstream waterways.

5. Many of the waterways in the project area are significantly degraded and in many locations banks and channels are covered with debris. Tenants operating lands adjacent to these waterways may not recognize the function or importance of these waterways. Often, the short-term agricultural leases do not provide incentives to the growers to enhance or clean up the waterway and in some instances the waterways can become clandestine dumps.
6. There is lack of coordinated maintenance or enhancement efforts between owner/managers and County or State departments. There is a need to develop long-term coordinated private and public agency partnerships to carryout conservation projects in each watershed area.
7. Increased workload, and budget and staffing constraints, in the County's Drainage and Road Maintenance Departments, has limited these departments ability to maintain drainage infrastructure in the project area. Over the past several years the Road Maintenance Department has only been capable of undertaking emergency repairs and preventive maintenance activities have been delayed by approximately 2 to 3 years.
8. Substantial permitting requirements combined with limited staff resources imposes a lengthy, cumbersome and expensive process to undertake drainage and stream improvement projects by both private and public parties. This condition has created a severe disincentive for private landowners to undertake voluntary improvement projects. Currently, permitting for drainage and stream improvement projects can take over two years to be completed.
9. Practices and/or structures adopted by one owner/manager, have led to or have compounded 'downstream' problems for another owner/manager.
10. There is a perception that vegetated banks restrict stream flow and cause flooding. However, major flooding problems in the lowlands are not the result of vegetation but rather channels filling with sediment that could be kept on upstream property by using vegetation on stream banks and riparian buffers.

## ES 3. ENHANCEMENT PLAN

Part II presents an enhancement plan to outline actions that may be taken to address erosion and sedimentation problems in the lower Pajaro Valley, as well as projects that can restore and enhance riparian and wetland resources in the area.

### ES 3.1.Overview

A variety of on-farm best management practices (BMPs) can be used to control runoff, reduce erosion and the transport of sediment off of croplands. Similarly, biotechnical bank stabilization practices can be put in place to protect, repair and restore stream and waterway banks. Section Six of the enhancement plan describes on-farm BMPs and biotechnical stream bank stabilization techniques that have been used throughout the Monterey Bay region. Cost and performance data is also provided, where information was available.

Section Seven presents a series of stream bank stabilization and wetland enhancement demonstration projects. The demonstration projects describe the site conditions, present conceptual restoration plans, a analysis of engineering design and permitting requirements, outlines the pre- and post project monitoring and maintenance requirements and cost estimates for the implementation of the project.

Technical, managerial and financial issues have limited routine maintenance, planning and enhancement projects in the study area. In general, there is a lack of coordinated maintenance or enhancement efforts between owner/managers and County or State Agencies. Some deferred maintenance activities are not occurring, exacerbating erosion and sedimentation problems. There is a need to develop long-term coordinated private and public agency partnerships to carryout drainage improvement and conservation projects in each watershed area. Substantial permitting requirements combined with limited staff resources impose a lengthy, cumbersome and expensive process to undertake drainage and stream improvement projects by both private and public parties. This condition has created a severe disincentive for private landowners to undertake voluntary improvement projects. Currently, permitting for drainage and stream improvement projects can take over two years to be completed. Section Eight describes management, planning and implementation issues and actions recommended to improve these activities in the study area.

Section Nine identifies activities that should be undertaken to implement the enhancement plan. Preliminary budgets and timelines are presented to assist the SCCRCD and other agencies in the planning and implementation of the proposed activities.

### ES 3.2.Best Management Practices for Enhancement Opportunities

A variety of alternative on-farm and bank stabilization best management practices (BMPs) can be used to stabilize sediment (source control) and to reduce erosion and the delivery of sediment from upland areas and waterways. The enhancement plan describes several well established techniques that are recommended by local, state and federal resource conservation agencies, including the Santa Cruz County Resource Conservation District and the Natural Resource Conservation Service to control runoff, erosion and stabilize banks.

All of the practices described are cost-effective methods that are designed to stabilize soil by primarily slowing runoff from the fields and by stabilizing stream and waterway banks that are experiencing excessive bank erosion. These two conditions are resulting in the most severe erosion and sedimentation problems in the Pajaro Valley region. Several of the recommended BMPs also provide additional benefits to the land by conserving soil, improving water infiltration and groundwater recharge, improving soil fertility, reducing costs for ongoing maintenance of infrastructure (access roads and drainage systems), reducing land loss, enhancing habitat and improving water quality.

Although, different practices are discussed separately, many of the practices may be used in combination. For example, sedimentation basins are recommended widely throughout the Monterey Bay region as a preferred method to capture sediment from croplands. However, if sedimentation basins are used as the sole BMP, they may occupy a relatively large area. Using a combination of BMPs as a "pre-treatment" system, such as cover crops, vegetated roadways, grass-lined channels, velocity dissipaters, filter strips, or other techniques, the total sediment load delivered to a sediment basin would be reduced. Therefore a smaller sediment basin could be designed to better accommodate the site and cropping system.

## Why Use BMPs?

In the Pajaro Valley, climatic, topographic and geological forces contribute to natural erosion and sedimentation processes in the local streams and the Pajaro River. However, erosion problems are accelerated by a variety of human activities. Uncontrolled erosion is costly; exposes landowners to legal liabilities; impairs water quality and water conveyance capacity in waterways; and can potentially violate local, state and federal water pollution laws.

### Economic Advantages

Adopting runoff, erosion and sediment control measures can provide numerous economic benefits to a landowner, neighborhood, and local and state agencies. Some of the benefits include:

- Stabilized sites require less repair and are safer for field workers;
- Reducing short- and long-term erosion will result in less soil loss;
- Reducing land loss due to streambank and ditch erosion;
- Reducing flooding hazards;
- Reducing removal of silt deposit from drainage ditches and sedimentation ponds;
- Negative public opinion, which can result in enforcement actions, can be minimized; and
- Liability exposure can be decreased

### Environmental Advantages

Similarly, adopting BMPs can provide several environmental benefits, including:

- Reduction of toxic materials that are introduced into waterways by their attachment and transport by sediment particles

- Protection of aquatic life in streams and waterways
- Protection of human and well as wildlife uses of receiving waters

## On-Farm Practices

Nine on-farm practices are presented in the plan. Each practice are described, cost and performance data is presented if it was available. A summary of this information is provided in Table ES1.

Table ES1. Summary of On-Farm Best Management Practices Information

| | Type of Practice | | | Overall Performance | | | Sediment Removal | | | | Cost | | | | Annual Maintenance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Practice** | Erosion Control | Sediment Control | Runoff Control | Moderate | Good | Excellent | Moderate | Good | High | **Sediment Removal Efficiency** | Low | Moderate | High | **Cost $/Acre** | Low | Moderate | High |
| **Farm/Ranch Roads** | | | | | | | | | | | | | | | | | |
| Water Bars/Rolling Dips | | | X | | X | | | X | | -- | X | | | $225.00 | | X | |
| Culverts | | | X | X | | | | X | | -- | | X | | -- | | X | |
| Energy Dissipator | | | X | | | X | | | X | -- | X | | | -- | X | | |
| Vegetated Roadbed | X | | X | | | X | | | X | | | X | | $574.00 | | X | |
| **Cover Crop** | X | | | | | X | | | X | 85-90 | | X | | $115.00 | | X | |
| **Critical Planting Area** | X | | | | X | | | X | | -- | | X | | -- | X | | |
| **Filter Strips** | X | X | | | X | | | X | | 70-90 | | X | | $447.00 | | X | |
| **Grassed Waterway** | | | X | | X | | | | X | 70 | | X | | $5 - $15/LF | X | | |
| **Contour Farming** | X | | X | | | X | | | X | 80-90 | | X | | $75.00 | | X | |
| **Sedimentation Basin** | | X | X | | X | | | | X | 70-90 | | | X | $1,000.00 | | | X |
| **Tailway Ponds** | | | X | | X | | | | X | -- | | | X | $1,000.00 | | | X |
| **Underground Outlets** | | | X | | X | | | | X | -- | | | X | $325 - $750 | | | X |

## Biotechnical Bank Stabilization

The enhancement plan presents five alternative biotechnical bank stabilization techniques that can be used to stabilize ditch and streambanks throughout he Pajaro Valley. Biotechnical bank stabilization methods incorporate hard structural elements and live vegetation to stabilize a stream bank. In streams these methods can be used to reduce velocities and shear stresses near the banks, reducing the risk of scour. On the slope vegetation can be used to slow overland runoff and increase the strength of the slope, in turn increasing the banks ability to resist erosion. As compared with traditional structural slope stabilization methods, biotechnical techniques are relatively inexpensive. Biotechnical methods are flexible techniques, which can be adapted for different sites. By employing vegetation into a bank stabilization method, with time the roots of the vegetation will become the main structural support of the bank or a portion of the bank. This allows the bank to be self-repairing, as older plants die new plants are established to replace them, providing long-term stabilization using active root structure of trees and shrubs, as opposed to a strictly structural alternative that will eventually need to be replaced. In addition to providing bank stabilization, the use of vegetation provides habitat in the stream and on the bank. Vegetation can also provide shade in the stream, reducing the water temperature and improving water quality.

### ES 3.3.Demonstration Projects

Section Seven presents three demonstration projects that are recommended in the study area. The first two projects will involve stream bank stabilization measures and are located in the Green Valley and Coward Creek watersheds. Each project will be constructed utilizing different biotechnical bank stabilization methods to repair highly eroded banks. The projects will illustrate how the use and integration of vegetation and structural materials can be employed to stabilize and enhance steam and riparian conditions in the Pajaro Valley.

The third project presents alternative conceptual wetland and stream restoration plans. The project will potentially restore between 18 to 30 acres of freshwater wetlands and approximately 2,000 lineal feet of stream channel in the upper College Lake basin. This project presents a unique opportunity to restore a relatively large tract of open space as a multi-use facility that would restore wetland and riparian habitat, create environmental education and recreational opportunities, and provide an alternative source of local water supply. Presently, there are very few publicly accessible wetland and riparian parklands in the Pajaro Valley that are within close proximity to the city of Watsonville. As the Pajaro Valley continues to become more urbanized, access to parklands will become more vital to the growing population.

Each demonstration project describes the project setting, a brief problem assessment and baseline information, including topographic, hydrologic and water quality data, if available or pertinent. A conceptual restoration plan is presented that identifies the principal goals and design criteria for the proposed enhancement project. A project analysis is also provided that outlines the various tasks that would be needed to implement the project, including the engineering design, biotic review, permitting and pre- and post project monitoring and maintenance. Lastly, project cost estimates have been prepared for all project elements, from planning through post project monitoring.

### ES 3.4.Management Planning and Implementation Issues

A variety of issues and potential constraints exist that can affect the implementation of enhancement projects throughout the Pajaro Valley. Project permitting can be a cumbersome and expensive process that at times can be an obstacle or disincentive for private landowners and public agencies to move forward with projects located in potentially sensitive habitat areas. Limited technical and financial resources have and will continue to affect project implementation. A lack of planning, coordination and collaboration between private and public parties has also caused project delays and/or suspensions. Little post project monitoring or evaluation has been carried out so that limited benefit-cost information is available for many best management practices in use or proposed in this plan.

Section Eight describes management planning and implementation issues and actions recommended to improve the planning and implementation of enhancement projects in the region. Six key issues are discussed including:

- Permitting;
- Coordination and implementation of ditch maintenance & drainage improvements;
- Technical assistance and project coordination;

- Safe harbor agreements;
- Lease agreements; and
- Future planning and project opportunities.

**Permitting**

Throughout the Pajaro Valley region many private landowners and farmers are interested in adopting conservation practices that can reduce erosion and improve water quality, such as stream bank stabilization measures and other drainage improvements. However, securing permits to implement these types of projects can generally require approval from a multitude of agencies, creating a process that can be complex, costly, and time-consuming. In contrast to the financial incentive to improve crop production, practices designed to improve water quality and protect sensitive habitat resources present uncertain economic returns. When faced with multiple permitting processes and uncertain outcomes from agency reviews, the adoption of some conservation practices is very limited.

The process to secure the individual permits from the various agencies is a disincentive for private landowners to adopt or undertake projects to reduce non-point source pollution and enhance habitat. Landowners and growers are likely to avoid conservation activities if the administrative and economic barriers exceed the potential benefits. Therefore, a challenge in implementing water quality and habitat enhancement activities in the Pajaro Valley will be to remove these disincentives.

Following the success of the coordinated permit program for Elkhorn Slough, Santa Cruz County has the potential to create a "user-friendly", streamlined permit program to promote the adoption of restoration and resource conservation efforts required to address water quality and habitat issues in the county. A joint effort is underway between the County of Santa Cruz Planning Department, the Resource Conservation District, the California Coastal Conservancy, the Natural Resource Conservation Service, and Sustainable Conservation to develop, maintain, and promote a countywide permit coordination program.

**Coordination and Implementation of Ditch Maintenance & Drainage Improvements**

Substantial erosion and sedimentation problems throughout the Pajaro Valley are attributed to aged, undersized and/or poorly maintained drainage infrastructure that includes roadside drainage ditches, culverts, drainage waterways and in some instances stream channels. Many of the drainage problems have also become exacerbated from land use conversions (e.g. conversion from orchards and pasture to row crops) in the area, which has either increased the amount of impervious surface or reduced field infiltration resulting in increased runoff flows.

The County of Santa Cruz is the lead agency responsible for the maintenance and repair of the majority of the road and drainage infrastructure in the area. Caltrans is responsible for drainage infrastructure installed along Highway 129. Historically, the County of Santa Cruz Road Department has maintained roadside ditches and the Pajaro Storm Drain Maintenance District (PSDMD) has maintained drainage courses, waterways, and streams. Discussions with the County's Drainage Division identified a number of constraints influencing the maintenance of ditches and natural channels, primarily related to budget, permitting, and planning. Drainage improvements typically have been undertaken in a piecemeal fashion and comprehensive drainage plans do not exist for the area. Drainage improvements are generally carried out to accommodate new infrastructure and/or development or to repair damaged facilities. A comprehensive drainage study(s) is needed to evaluate existing drainage and waterways and to identify and plan alternative drainage improvements to accommodate the conversion of land use and the drainage modifications that have occurred over the past fifty years in the area.

Currently, no clear mechanism allows landowners or land managers to work cooperatively with the appropriate County departments or organizations for the timely and effective maintenance or improvement of drainage infrastructure. Any proposal to better coordinate ditch and drainage improvements and maintenance in the Lower Pajaro is critical to address long-term erosion and sedimentation issues in the area. A coordinated effort between private and public entities to plan, coordinate, and implement drainage activities should be facilitated under the jurisdiction of the PSDMD and the County of Santa Cruz.

There are a number of ongoing projects that could serve to improve communication and coordination of maintenance activities in the lower Pajaro Valley. The plan outlines several mechanisms that could be put in place to improve communication, policy and planning, and pubic-private coordination without creating another parallel process that may duplicate effort.

## Technical Assistance and Project Coordination

Over the past several years, various agencies and organizations have expanded their resource conservation programs substantially, and with the recent approval of the Farm Bill, additional financial and technical resources will be available to NRCS and landowners for conservation projects in the Pajaro Valley. Based on the discussions with various agency staff and landowners, a variety of technical assistance needs have been identified and are discussed in the plan. Five major areas have been identified, including:

- Field Assessment and Project Support
- Engineering Design
- Cost-Benefit Information
- Project Coordination
- Project Evaluation
- Priority Activities

**Field Assessment and Project Support.** One-on-one field assessment activities are a major focus of the RCD and NRCS staff to properly assess and design conservation projects. This approach is critical to the success of long-term soil conservation efforts in the region; however, the work is very resource intensive. Additional technical field staff are needed to conduct the field assessment activities with landowners and growers to identifying on-farm management practices or projects to stabilize gullies and streambanks.

**Engineering Design.** Many conservation projects require civil engineering support as part of the design and permit phase. Currently, the RCD relies on engineering support provided by the NRCS. Currently, there is up to an 8 month backlog for engineering support in the Monterey Bay region, covering the Monterey, Santa Cruz and San Mateo Counties.

Additional technical design assistance is needed to address many on-farm runoff, erosion and sediment control issues.

**Benefit and Cost Information.** Currently, there is limited information to demonstrate the environmental or financial benefit for implementing conservation practices. However, the long-term benefits for any conservation project should be determined as part of the planning process. This will require a clear understanding of farm economics and the costs of implementing recommended practices. Currently, the RCD, NRCS and UC Cooperative Extension (UCCE) are compiling performance and cost data to initiate a database that will provide growers and landowners baseline information to evaluate the cost and benefits of employing conservation projects. Future research efforts should also be directed at monitoring and performance studies to evaluate the benefits of conservation practices.

**Project Coordination and Outreach.** Currently, there are several different agencies and organizations carrying different programs aimed at on-farm soil conservation practices and improving water quality. The traditional role for the RCD will include acting as liaison between land users and resource/regulatory agencies and offering workshops and trainings for land users on topics they request. These activities are on-going and will be enhanced by special project grants in targeted priority areas. Another key role of the RCD will be to continue to assist in the coordination of the various conservation programs underway.

**Project Priorities.** Over the next few years, the RCD and NRCS will continue to prioritize projects in the Watsonville Sloughs and other watershed areas in the Pajaro Valley. These projects will include the establishment of grass along the entire length of the Beach Road ditch, construction of sediment detention basins and buried drain structures in the highly erodable San Andreas area adjacent toWatsonville Slough, gully repair, and habitat restoration in the Buena Vista Rd. area. Another on-going project will be assisting in drainage improvement projects in the Thompson Road area in the Coward Creek watershed.

## Future Planning and Project Opportunities

The enhancement plan presents several future planning and project opportunities, including:

- Drainage master planning;
- Technical training and evaluation;
- Project monitoring and evaluation;
- Demonstration projects; and
- Coordination research

**Drainage Master Planning.** The County of Santa Cruz should allocate a percentage of annual funds to begin to conduct drainage studies in the subwatershed areas of the Pajaro Valley. The studies should include an assessment of existing drainage infrastructure, identification of key problem areas, and recommended improvement projects.

**Technical Training and Evaluation.** Over the past several years the RCD and NRCS has undertaken a variety of projects to address erosion control on agricultural lands. To transfer this experience to private landowners and other local agencies, ongoing technical workshops or trainings are recommended. The NRCS has also been allocated substantial funds to carryout agriculturally related environmental enhancement projects. Forums are needed to inform private landowners how they may apply for these program funds. A series of workshops are recommended to address erosion and to promote environmental enhancement projects on private lands in the Pajaro Valley.

**Project Monitoring and Evaluation.** Over the past several decades the NRCS and other agencies have worked with landowners to install many practices. Limited resources have been available to construct the project and even less funds and staff resources are provided to conduct post construction monitoring and evaluation. Limited field data is available to allow for a benefit-cost analysis of BMPs. As projects are funded, dollars need to be allocated to post project monitoring and evaluation. There is also a need to develop standardized monitoring and evaluation procedures.

**Demonstration Projects.** Demonstration projects are an important means to show their application, function, benefits and costs. Ongoing outreach efforts by the RCD, NRCS and other organizations should continue to assist in the development of demonstration projects related to on-farm drainage and erosion control, water conservation and nutrient management, ditch maintenance and bank stabilization techniques.

**Coordinated Research.** Often agricultural research is not coordinated nor focused on priority issues, such as erosion control and nutrient management in full-scale demonstration projects. While many state and local technical resource groups (UCCE, NRCS, RCD) have been linked under the Sanctuary Agricultural Water Quality Alliance additional project proposal coordination would ensure that specific efforts are made to evaluate the performance and benefit-cost of local demonstration projects.

### ES 3.5.Planning and Implementation

A series of demonstration projects and programmatic activities are outlined in this study. The final section of the plan presents proposed planning and implementation activities that should be undertaken to implement the enhancement plan. Implementation activities has been divided into three main categories: demonstration projects, drainage master planning and technical workshops. Preliminary budgets and timelines have been outlined for each proposed activity.

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# 1. INTRODUCTION

The Pajaro River Watershed is one of the largest riverine systems entering the Monterey Bay and drains an area of approximately 1,300 square miles of land in Central California.

Historical and current land use practices continue to impact water quality in the main areas of the watershed. The predominant land use practices in the Lower Pajaro River and its tributaries include irrigated croplands, rangelands, urbanization and rural residential development. Each of these land use practices can potentially contribute a variety of pollutants such as sediments, nutrients, pesticides, pathogens, oil and grease to waterways in the watershed.

Physical habitat quality assessments completed by the California Department of Fish and Game (CDFG) in 1998 indicate that sediment deposition is a significant water quality problem in the Pajaro River watershed. This is exemplified in the lower Pajaro River and Corralitos-Salsipuedes Creek where high accumulation of sediment have covered larger gravel bottom substrates, which are important for salmonid (steelhead) spawning and rearing habitat. Additional studies conducted by the CDFG have detected elevated levels of DDT and other residual persistent pesticides that continue to enter the Pajaro River from eroding soils from adjacent lands. The levels of residual pesticides detected at times, typically during storm events, can exceed water quality objectives to protect aquatic life. The Pajaro River and several tributary streams are considered, by both state and federal agencies, to be water quality impaired due to sedimentation.

Excessive erosion and sedimentation is also resulting in loss of agricultural soils, roads, riparian and stream habitat. Many natural and human induced factors contribute to, or exacerbate erosion and sedimentation problems in the lower Pajaro River watershed. Natural and generally uncontrollable and significant sediment sources include landslides and slumps, which are common along the San Andreas Fault Zone in the upper watershed lands in the Santa Cruz Mountains. Increased runoff from recently converted croplands from orchards and rangeland directed to aged, failing and poorly maintained infrastructure (drainage ditches, culverts and roads) is causing severe erosion problems in many locations throughout the watershed. Stream bank instability due to removal and/or loss of riparian vegetation in the low watershed areas is also resulting in acute erosion and sedimentation problems in the watershed.

The Santa Cruz County Resource Conservation District (SCCRCD) has undertaken this enhancement planning study to assess erosion and sedimentation problems in several tributary watersheds in the Lower Pajaro River watershed. The tributary streams studied are characteristic of Central Californian coastal streams located in agricultural valleys. The development of the enhancement plan is being supported by a grant jointly funded by the California Coastal Conservancy and the California Regional Water Quality Control Board.

A key goal of this enhancement plan is to work in cooperation with landowners, land managers, and agency staff to assess historical and existing conditions in order to determine principal factors causing significant erosion and sedimentation problems in the areas studied. Once a baseline study is completed, enhancement strategies can be developed to address and reduce drainage and erosion problems in the study area.

The initial phase of the project includes an assessment of existing conditions. Field assessments were carried out with cooperative landowners/managers, agency staff and at public access points. They were conducted on up- and lowland areas, riparian corridors and streams. Up- and lowland assessment activities focused on critical water, soil, and/or vegetation management practices or structures. The riparian and stream survey assessment portion of the study evaluated riparian vegetation, channel stability, bank conditions, and erosion and sedimentation impacts. The assessment included development of geographic information system (GIS) map layers describing land use, soil classification, and general channel characteristics (stream type, position and location). Utilizing the GIS maps and field assessment data, summary statistics were calculated for a variety of parameters including; distribution of slope classes; acreage of erosion-prone soils; and streambank erosion potential.

The second phase of the project includes development of an enhancement plan for the study area. The objectives of the enhancement planning stage of the project was to identify and evaluate both programmatic and structural projects, which can be initiated to address long-term drainage and soil conservation practices in the area.

A variety of alternative on-farm and bank stabilization best management practices (BMP) are presented in Section 6 that can be used to stabilize sediment (source control) and to reduce erosion and the delivery of sediment from upland areas and waterways. All of the practices described are cost-effective methods designed to stabilize soil by primarily slowing runoff from the fields and by stabilizing stream and waterway banks that are experiencing excessive bank erosion. These two conditions are resulting in the most severe erosion and sedimentation problems in the Pajaro Valley region. Several of the recommended BMPs also provide additional benefits to the land by conserving soil, improving water infiltration and groundwater recharge, improving soil fertility, reducing costs for ongoing maintenance of infrastructure (access roads and drainage systems), reducing land loss, enhancing habitat and improving water quality. Practices described are well established techniques, recommended by local, state and federal resource conservation agencies, including the Santa Cruz County Resource Conservation District and the Natural Resource Conservation Service.

Three demonstration projects are presented in Section 7. The first two projects will involve stream bank stabilization measures and are located in the Green Valley and Coward Creek watersheds. Each project will be constructed utilizing different biotechnical bank stabilization methods to repair highly eroded banks. The projects will illustrate how the use and integration of vegetation and structural materials can be employed to stabilize and enhance steam and riparian conditions in the Pajaro Valley. The third project presents alternative conceptual wetland and stream restoration plans for a 50-acre site in the upper College Lake basin. The project will potentially restore between 18 to 30 acres of freshwater wetlands and approximately 2,000 lineal feet of stream channel. This project presents a unique opportunity to restore a relatively large tract of open space as a multi-use facility that would restore wetland and riparian habitat, create environmental education and recreational opportunities, and provide an alternative source of local water supply.

Each demonstration project describes the project setting, a brief problem assessment and baseline information, including topographic, hydrologic and water quality data, if available or pertinent. A conceptual restoration plan is presented that identifies the principal goals and design criteria for the proposed enhancement project.

A variety of management or programmatic issues and potential constraints can affect the implementation of enhancement projects throughout the Pajaro Valley. Project permitting can be a cumbersome and expensive process, which can be an obstacle or disincentive for private landowners and public agencies to move forward with projects located in potentially sensitive habitat areas. Limited technical and financial resources have and will continue to affect project implementation. A lack of planning, coordination and collaboration between private and public parties has also caused project delays and/or suspensions. Little post project monitoring or evaluation has been carried out so that limited benefit-cost information is available for many best management practices in use or proposed in this plan. Section 8 presents a series of recommended programmatic activities, including the need for drainage master planning, technical training and evaluation projects, and additional demonstration projects.

Section 9 presents proposed planning and implementation activities that should be undertaken to implement the enhancement plan. Preliminary budgets and timelines have been outlined for each proposed activity.

# 2. PROJECT AREA DESCRIPTION

## 2.1. Watershed Description

The project area is located in the Lower Pajaro River watershed in the Pajaro Valley. Watershed assessment activities were conducted in several tributary watersheds including Green Valley, Casserly, Hughes, Tynan, Coward and Thompson Creek watersheds. All of these streams originate in the Santa Cruz Mountains, drain to the Pajaro River and are located in Santa Cruz County, California. The project area encompasses approximately 23,275 acres (15 square miles). A map delineating the project area is shown in Figure 2.1.

The project area is located within the San Andreas Fault Zone, which is a very dynamic tectonic region. The major faults in the Santa Cruz Mountains have strongly influenced the physiography and drainage, both by relative movements of the blocks between them or by folds produced in them. The sculpturing of the surrounding mountain ranges has been strongly affected by the zones of weakness resulting from the faulting and folding.

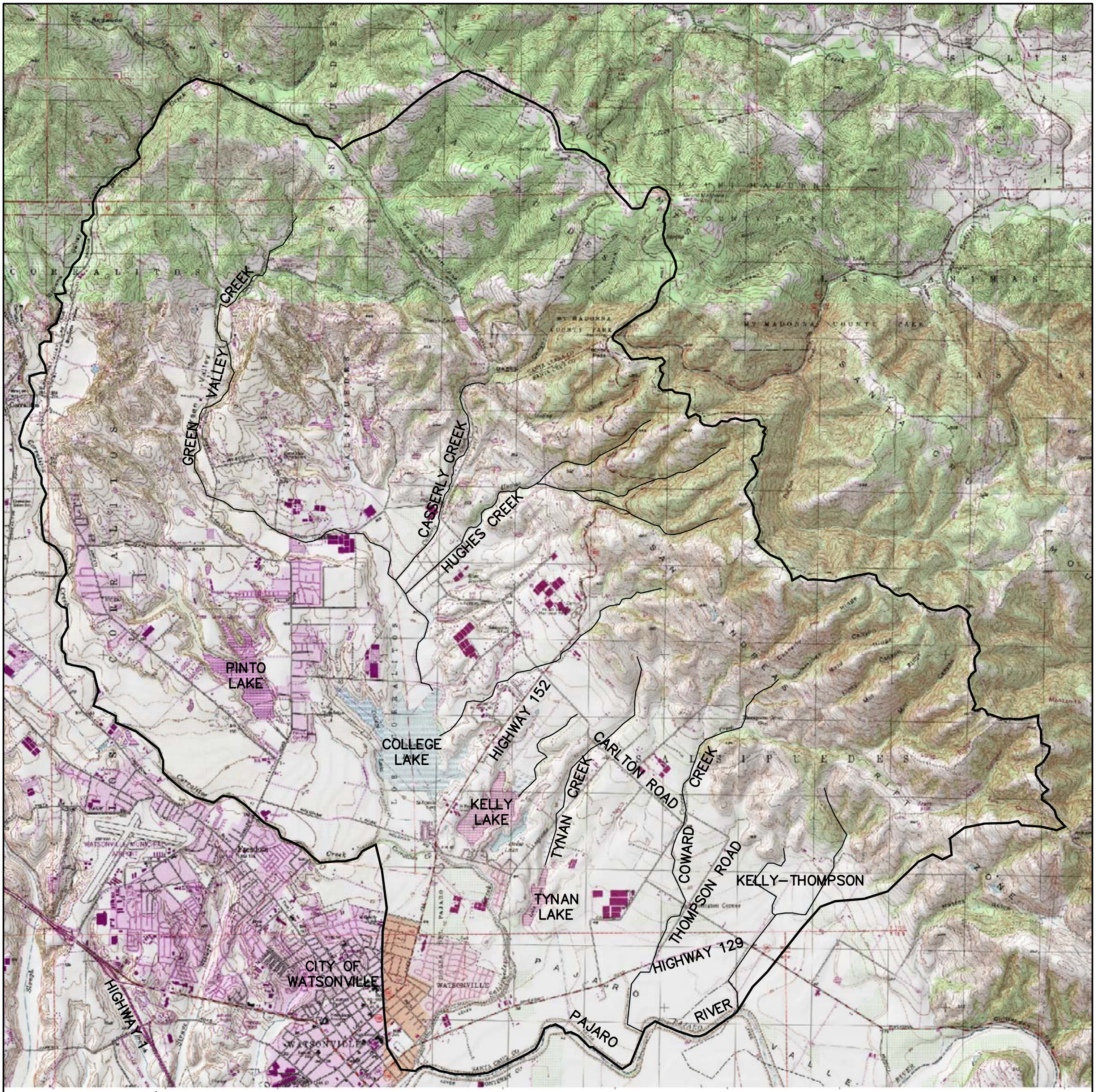
All of the watersheds originate in the Santa Cruz Mountains where streams are very steep, deeply entrenched and confined with cascading reaches. The watersheds are set in areas of high relief and the streambeds are both erosive and bedrock form. A majority of the streams have relatively small watersheds, which have very short lag times between precipitation events and high peak runoffs and limited seasonal baseflow. Longitudinal stream gradients range from 10 to 30 feet per mile in alluvial valley reaches and as much as 600 feet per mile in the headwaters. Leaving the mountainous regions, the streams drain into the alluvial valley floor where many of the stream courses have been modified and channelized.

Land use activities in each watershed are primarily dictated by topography, geology and climate conditions. Principal land uses in the upper watershed areas include rangelands, timberlands and rural residential developments. Croplands, orchards, nurseries and the urbanized area of the City of Watsonville are the predominant land uses in the valley floor.

Over the past 15 years land conversion activities from orchards to row crops has been occurring on the relatively level valley floors. Strawberry and cane- or bushberry production has increased dramatically on foot slope areas where erosion risks are generally higher. A substantial increase in rural residential development has also occurred over the past 10 years in many of the upper watershed areas, most notably in the Green Valley and Casserly Creek watersheds. Changes in land use have dramatically affected drainage, erosion and sedimentation conditions in the watershed.

## 2.2. Jurisdictions

The majority of lands in the project area are privately owned and landowner(s) or owner agents are responsible to control erosion and sedimentation on these lands. Whereas, it is the responsibility of public agencies to control erosion and sedimentation on public easements, public right-of-ways and/or public lands (including roads).




SCALE: 1"=6000'

PROJECT AREA BOUNDARY

FALL CREEK ENGINEERING, INC.
Civil • Environmental • Water Resources Engineering

FIGURE 2.1. MAP OF PROJECT AREA

2.2.1. Drainage

The project area is within the jurisdiction of the Pajaro Storm Drain Maintenance District (PSDMD). The PSDMD was established in 1939 to provide a mechanism to assess private lands in the District to fund routine operation, maintenance and improvements of the drainage courses, streams and flood control structures in a majority of the lower Pajaro Valley. (The Zone 7 District was setup to operate separately from the PSDMD and is responsible for the maintenance of the lower Pajaro River and the lower reach of the Salsipuedes-Corralitos Creek)

2.2.2. Roads and Highways

The project area is within Road Maintenance District D of the Santa Cruz County Department of Public Works Maintenance Division. The road maintenance district is responsible for maintaining county roads and related drainage systems (drainage ditches along roads, culverts and bridges).

Two state highways, Highway 129 and Highway 152, run through the project area. The maintenance of the highways and the related drainage systems is the responsibility of the State Department of Transportation (CalTrans).

## 2.3. Topography

Table 2.1 summarizes the distribution of slope classes. The valley floor that is predominantly used for agricultural production represents about 43 percent or slightly over 10,000 acres of the total project area. The steeper mountainous regions (> 15 percent slope) that naturally supply significant sediment loads to the lowlands make up about percent or about 7,150 acres in the project area. Appendix A provides the distribution of slope classes on a study subarea basis.

Table 2.1. Distribution of slope classes in the project area

| Slope % | Acreage | % of area |
|---|---|---|
| < 2 | 5,839 | 25.1 |
| 2 – 5 | 4,183 | 18.0 |
| 5 – 9 | 2,705 | 11.6 |
| 9 – 15 | 3,391 | 14.6 |
| 15 – 30 | 5,738 | 24.7 |
| 30 – 50 | 1,410 | 6.1 |
| 50 – 75 | 8 | <0.1 |
| TOTAL | 23,274 | 100.0 |

## 2.4. Soils in the Project Area

The soils reflect the varied topography, geology, and other soil formation factors typical of the Central Coast Region. These soils are largely grouped into five landscape types as follows:

*Alluvial plains and fans*
These soils are very deep, well to poorly drained, and formed in alluvium of primarily sedimentary rocks. These soils may be found on level to strongly sloping terrain. These soils are largely used for crop production and housing. Erosion hazards are usually low to moderate.

*Marine terraces and hills*
These soils are deep to very deep, well to somewhat poorly drained, and formed from fine-grained rock and old alluvium. These soils are found on level to moderately steep terrain. These soils have been used for crop production, and increasingly, for housing. Erosion hazards can be low to extreme.

*Sand dunes, hills, and mountains*
These soils are deep to very deep, well to excessively drained, and formed from coarse grained-rock and sands. These soils are found on gently sloping to steep terrain. Some of the gently sloping areas are used for crop production and grazing, while the steeper sites are primarily for wildlife habitat, recreation, and mining.

*Forested Mountains and hills*
These soils are deep to moderately deep, well to somewhat excessively drained, and formed from fine to coarse-grained rock. These soils are found on moderately sloping to very steep terrain. These soils are used mainly for timber and firewood, wildlife habitat, and recreation, although housing and grazing are becoming more predominant uses locally.

*Mountains and hills grass and brushlands*
These soils are deep to shallow, well to somewhat excessively drained, and formed predominantly fine-grained rock. These soils are found on moderately sloping to extremely steep terrain. These soils are used primarily for rangeland and wildlife habitat.

*Erosion-Prone Soils*
Within the project area, there are a number of soil types that are potentially more 'at risk' for erosion when used for timber, crop, or range production. All of these soils, with the possible exception of the Baywood sands series, are found on sloping terrain. However, it was noted during the assessment that soils in the alluvial plans become quite susceptible to erosion loss when water management practices or structures increase runoff rates and overwhelm the drainage systems. Table 2.2 provides the area extent of erosion prone or 'at risk' soils within the study area, as derived from the Soil Survey for Santa Cruz County (USDA, 1980). These soils are largely upland soils on slopes greater than 15 percent and are utilized largely as range and timberlands, in addition to housing, wildlife habitat and recreation. A total of 2,941 and 7,016 acres (12.6 and 30.1 percent) in the study area have high or very high and moderate erosion potential, respectively.

Table 2.2. Soil series in the study area with significant erosion potential

| Soil Series | Acres |
|---|---|
| ***High Erosion Potential*** | |
| Aptos loam (30-75 percent slope) | 158 |
| Bonnydoon loam (30-85) | 260 |
| Diablo clay (5-30) | 179 |
| Fagan loam (30-50) | 20 |
| Lompico-Felton complex (30-75) | 518 |
| Los Osos loam (30-50) | 12 |
| Madonna (15-30) | 105 |
| Maymen (15-75) | 636 |
| Nisene (15-75) | 187 |
| Pfeiffer (15-50) | 138 |
| Santa Lucia (15-50) | 355 |
| Tierra(15-50 | 371 |
| ***Moderate Erosion Potential*** | |
| Aptos loam (15-30 percent slope) | 1,141 |
| Baywood (0-30) | 876 |
| Bonnydoon loam (5-30) | 639 |
| Diablo clay (9-15) | 135 |
| Fagan loam (9-30) | 184 |
| Lompico-Felton complex (5-30) | 2,305 |
| Los Osos loam (5-30) | 719 |
| Tierra (2-15) | 1,017 |

Appendix B summarizes the extent of these soils in each of the study subareas.

**2.5. Conditions and Land Use in the Sub-Watersheds**

Generally, the valley floor is utilized for row crop production, agricultural accessory structures, and to a lesser degree housing. Vegetable row cropping still dominates the study region, however strawberry and cane- or bushberry production is expanding, and becoming very important in some subareas. Grazing and timber production is the dominant land use in the upland portions of the study area. The amount of land in grazing and timber harvest practice has remained relatively constant over the past several decades. However, the amount of rural residential development has increased substantially in the past decade, most notably in the Green Valley and Mt. Madonna area.

In order to describe land use in the project area the following section divides the study area into subareas. The boundaries of these subareas were approximated subjectively (rather than based on a topographic assessment) in order to enhance the analysis of soils, erosion potential, land use, and specific localized problems and possible solutions. These subareas are defined generally based on the estimated watershed areas of significant creeks in the study area.

Appendix C provides a summary of land use patterns in the study area developed using the County of Santa Cruz Planning Department's land use (Planning Department) database. Utilizing this database provides an approximate rather than an accurate description of land use in the study area, because the database is not routinely updated to reflect the many changes that occur between irregular updates. The land use categories in the database do not specifically identify uses, such as grazing or range lands and it was found that these lands likely fell under four different land use categories. Additionally, some of the coding used by the Planning Department does not clearly indicate the specific land use. Thus, in some cases, the land use data was confirmed based on experience, subjective knowledge and aerial photographs.

***Casserly***
This subarea is approximately 1,800 acres of which about 19 percent are utilized for farming and grazing. Berry crop production can account for the largest row crop area (28 percent of farmed area) in any given year. Homes, or ranches occupy almost 51 percent of the area. Over 51 percent of the total land area are slopes greater than 15 percent and are generally used for grazing, timber, and habitat. Over 29 percent of the land area has soils that have a high or very high erosion potential and slightly over 40 percent of the area has soils with a moderate to high erosion potential. Despite the high proportion of potentially erodable soils, much of the land use in these upper watershed areas (timber, rangeland, and housing) does not appear to be contributing to excessive sediment transport to the lower watershed areas.

***College Lake***
This subarea is approximately 1,850 acres of which about 59 percent are utilized for farming and grazing. Vegetable crop production can account for the largest row crop area (37 percent) in any given year. Over 21 percent of the land area are used for residences and residential properties. Only about 1 percent of the total land area has slopes greater than 15 percent. Less than 1 percent of the land area have soils with high or very high erosion potential, and slightly over 14 percent of the area have soils with a moderate to high erosion potential.

***College Lake East***
This subarea is approximately 1,110 acres of which about 60 percent are utilized for farming and grazing. Vegetable and berry crop production occurs predominantly on the valley floor and covers approximately 14 percent of the area. Almost 28 percent of the land area are used for residences and residential properties. Over 33 percent of the total land area are slopes greater than 15 percent and are largely on range and timber lands. Almost 10 percent of the land area have soils with high or very high erosion potential and 27 percent of the area has soils with a moderate to high erosion potential.

***Green Valley***
This subarea is approximately 4,621 acres of which about 60 percent are utilized for farming and grazing. Orchard and timber production may account for the largest uses (33 percent) in any given year. Almost 30 percent of the area are used for rural residences, or ranches with residences. Wholesale nursery production (2.5 percent) occurs on more land than berry or vegetable cropping. Over 47 percent of the total land area are slopes greater than 15 percent and support heavy forest cover in some locations. Approximately 10 percent of the land area have soils with high or very high erosion potential and slightly over 49 percent of the area have soils with moderate to high erosion potential. Despite the large area of highly erodible soils, sediment transport from the upper watershed areas is not as significant, as compared to sedimentation due to bank instability in the valley floor portions of the area.

***Spring Hills***
This subarea is approximately 1,620 acres of which about 32 percent are utilized for farming and miscellaneous grazing. Orchard production has been more important in the past and now may

account for the largest crop area in any given year. The Spring Hills Golf Course covers approximately 10 percent of the area. Residential properties, as homes, ranchettes, and larger rural residential properties occupy over 51 percent the land area. Over 23 percent of the total land area are slopes greater than 15 percent and include significant areas of rural residential homes. Slightly over 8 percent of the land area has soils with high or very high erosion potential, and over 37 percent of the area has soils with a moderate to high erosion potential.

***Hughes***

This subarea is approximately 1,840 acres of which about 25 percent are utilized for farming and grazing. Timber lands account for about 30 percent of land use in the subarea in any given year. Residential sites, ranchettes, and ranches are the dominant land use in this subarea (approximately 42 percent). Over 43 percent of the total land area are slopes greater than 15 percent. Slightly over 29 percent of the land area has soils with high or very high erosion potential, and over 58 percent of the area has soils with moderate to high erosion potential.

***Kelly Lake***

This subarea is approximately 685 acres of which about 56 percent are utilized for farming. Vegetable and berry production is important and combined may account for over 24 percent of land use in any given year. Almost 30 percent of the area are used for residential properties. Only 2.5 percent of the total land area are slopes greater than 15 percent and less than 1 percent of the area have soils with moderate to high erosion potential.

***Pinto Lake***

This subarea is approximately 1,850 acres of which about 38 percent are utilized for farming. Housing is an important land use, occupying approximately 29 percent of the area. Orchard production has been important in the past and may still occur on about 12 percent of the land area in any given year. About 12 percent of the total land area are slopes greater than 15 percent. Over 6 percent of the land area has soils that have a high or very high erosion potential and over 21 percent of the area has soils with a moderate to high erosion potential.

***Salsipuedes***

The subarea is approximately 1,210 acres of which about 48 percent may be utilized for farming. Vegetable and berry crop production may occur on over 20 percent of the area. Orchard production was at one time important and may now occur on less than 10 percent of the area. Residential properties now account for about 25 percent of the area. This subarea is entirely within the valley floor portion of the study area, and therefore none of the land area has soils with high or very high erosion potential. However there is a large extent of Baywood soils in the subarea (24 percent) with moderate erosion risk under certain land uses or on slopes greater than 2 percent.

***Coward***

This subarea is approximately 3,010 acres of which about 97 percent are utilized for farming and grazing. Rangeland use can occupy 84 percent of this subarea, while vegetable and berry production are important in the valley floor portion (over 12 percent). Over 59 percent of the total land area are slopes greater than 15 percent and is predominantly rangeland with timberlands occupying only a small portion of the upper watershed acreage. Over 28 percent of the land area have soils with high or very high erosion potential, and over 39 percent of the area have soils with moderate to high erosion potential. This area experience perhaps the greatest amount of sedimentation each year due to the combination of geology, slope, soil types and land use.

***Tynan***
This subarea is approximately 1,740 acres of which about 81 percent are utilized for farming. Vegetable and berry production can account for almost 50 percent of the land area in any given year. This subarea is also largely within the lower valley floor portion of the study area and less than 6 percent is on slopes greater than 15 percent. Less than 0.1 percent of the land area have soils with high or very high erosion potential, and only 9 percent of the area have soils with moderate to high erosion potential.

***Thompson***
This subarea is approximately 1,640 acres of which about 94 percent are utilized for farming. In the past orchard production was important (28 percent), but recent conversions to berry, flower and vegetable production (over 35 percent) has probably reduced orchards to less than 10 percent. The upland areas are largely used for rangelands (at least 25 percent). About 23 percent of the total land area are slopes greater than 15 percent. Only 2 percent of the land area have soils with high or very high erosion potential, while over 27 percent of the area have soils with moderate to high erosion potential. This area is also a source of significant sediment during the winter season.

***Highway 129***
The subarea is approximately 300 acres of which almost 100 percent (excluding roads and miscellaneous buildings) are utilized for vegetable and flower production. This small area was separated in our analysis from the Tynan, Coward, and Thompson areas due to the existence of an old drainage system that has an outlet into the Pajaro River. About 8 percent of the total land area are slopes greater than 2 percent (all less than 5 percent) and the remaining land is less than 2 percent. None of the land area has soils that have a moderate to high erosion potential.

## 2.6. Stream System

### 2.6.1. Overview
The primary streams draining the lower Pajaro Valley that are of interest in this report include Casserly (including Salsipuedes Creek), Coward and Thompson creeks and some smaller drainages between, as shown in Figure 2.2. The watersheds draining these creeks can be divided into two general landforms that dictate the channel conditions and sediment regimes: mountain and coastal plain, as shown in Figure 2.3.

The mountainous portion of each watershed lies in the south end of the Santa Cruz Mountains. This terrain consists of a steep, dissected landscape with shallow, erodible soils underlain by highly fractured sedimentary rock. The region also lies on top of several active fault plains, most notably the San Andreas. The active zone of faulting results in the formation of highly erodible clay soils, geologic control of drainage patterns and the presence of slumps and seeps.

Due to the presence of steep mountain fronts in close proximity to the ocean, wet, winter frontal storms are lifted up over the mountains, releasing large amounts of precipitation as the air mass is cooled. This process is known as orographic uplift and can result in intense rainfall events during the winter months on the order of several inches in the period of a few hours. This intense precipitation, combined with steep terrain and erodible soils, results in high erosion rates off the hillslopes with high potential sediment transport capacities in the stream channels. The majority of the sediment delivered from the hillslope is the result of landslides, soil slumps and debris flows that deliver an assortment of grain sizes to the channel. Since these erosion events often occur during intense storms, when streamflow is high, the delivered sediments are immediately sorted with the finer grained portion being transported to lowland areas.

The character of the channels in the mountainous reaches of Casserly and Coward Creek watersheds are dictated by sediment supply, available stream power and the presence or absence of channel structure. Stream power can be loosely defined as the available energy to do work on the channel and is a function of channel width, depth and gradient. Stream power is typically higher in headwaters where channels are steep and narrow. Higher stream power results in movement of larger sediment sizes as evidenced by cobble/boulder/bedrock streambeds in headwater streams. This contrasts with conditions in lowland areas where the streambed may be dominated by finer-grained sediment due to less stream power available to move sediment. Channel structure influences how the sediment will be routed, sorted and stored within the channel, acting as roughness elements to influence these processes. Structural elements include bedrock outcrops, boulders and large woody debris. Numerous studies conducted in the coastal ranges of California and Oregon suggest that large woody debris plays a primary role in maintaining channel form and function by storing sediment, providing hydraulic variability and reducing channel downcutting (Keller and Swanson, 1979; Keller et. al., 1981).

The lowland areas of the Casserly and Coward Creek watersheds consist of incised channels cut into extensive alluvial deposits. The Zayante Fault Zone cuts across the study area resulting in perennial and intermittent lakes that provide hydrologic control to Casserly Creek and other small drainages (e.g. – Kelley Lake and Tynan Lake drainages).

Prior to agriculture as the dominant land use, very little runoff occurred from land adjacent to lowland stream channels. Instead the lowland stream channels conveyed water from the mountainous reaches and recharged the lower Pajaro River aquifer.

A significant change in slope occurs as the streams within the study area leave the confined mountainous areas and flow out onto the coastal plain. The result is a reduction in available stream power as the channel gradient decreases and the flow becomes wider and shallower. Sediment-laden water reaching the coastal plain is deposited, resulting in aggradation of the bed.

Aggradation is defined as the process in which sediment is deposited on the bed of a stream, resulting in the elevation of the bed to increase over time. Conversely, channel degradation is the process of erosion of the channel bed resulting in a decrease in the elevation of the bed over time. Impacts from each depend on the rate of the process and the overall geometry of the channel. Channel aggradation can result in chronic and more frequent flooding if structures and roads occur adjacent to the stream channel as the cross-sectional area of the channel decreases. Channel degradation can result in loss of riparian vegetation as the water table lowers and more frequent landsliding as the valley walls become oversteepened and unstable.

Historically, channel aggradation would result in a dynamic channel system that would meander across the alluvial coastal plain. As a channel aggraded, new channels would form, further building the alluvial surface, providing deposits of rich soil with high mineral content.

As agriculture began to dominate the local land use, the process of channel migration and alluvial plain development became incompatible with the needs of the farmers. The meandering channels were subsequently straightened, narrowed and confined. In many cases, the result of this action has been steepening of streambanks, channel downcutting, and loss of riparian vegetation, agricultural lands and roads.

The dominant influence on the primary channels within the study area is the general trend and zone of influence of the San Andreas Fault Complex. In the subwatersheds where the San Andreas Fault occurs in the steep, upper reaches of the stream, the channels are characterized by high sediment loads, landslide failures and bank slumping, and aggradation of downstream reaches. These conditions occur in Thompson, Coward, Tynan-Martin and College East streams. Elsewhere, the San Andreas Fault Zone runs through the middle reaches of the stream system where the hillslopes are not as steep, resulting in less sediment generation and delivery to stream channels.

Due to movement along the San Andreas, several of the larger subwatersheds (e.g. – Green Valley, Coward), have developed upland, low gradient valleys that run parallel to the fault trend. These areas can act as sediment storage sites in the event of large slumps or failures of fine-grained sediment. Poor land use practices, road building, and channelization of these upland valleys can result in loss of sediment storage function that can have a considerable impact downstream. These impacts can include increased bank erosion as the channel cuts down through the alluvial fill, reduced storage capacity and increased sedimentation in downstream reaches.

The study area includes the three main watershed areas of Casserly, Coward and the various other small drainage basins (e.g. – Tynan-Martin, Pinto, Kelly), each of which could be further divided into smaller subwatersheds. Figure 2.4. presents a map delineating the various subwatersheds included within the project area. Table 3.1 presents information pertaining to the length, type and position of the stream or lake.

2.6.2. Casserly Creek Watershed Description

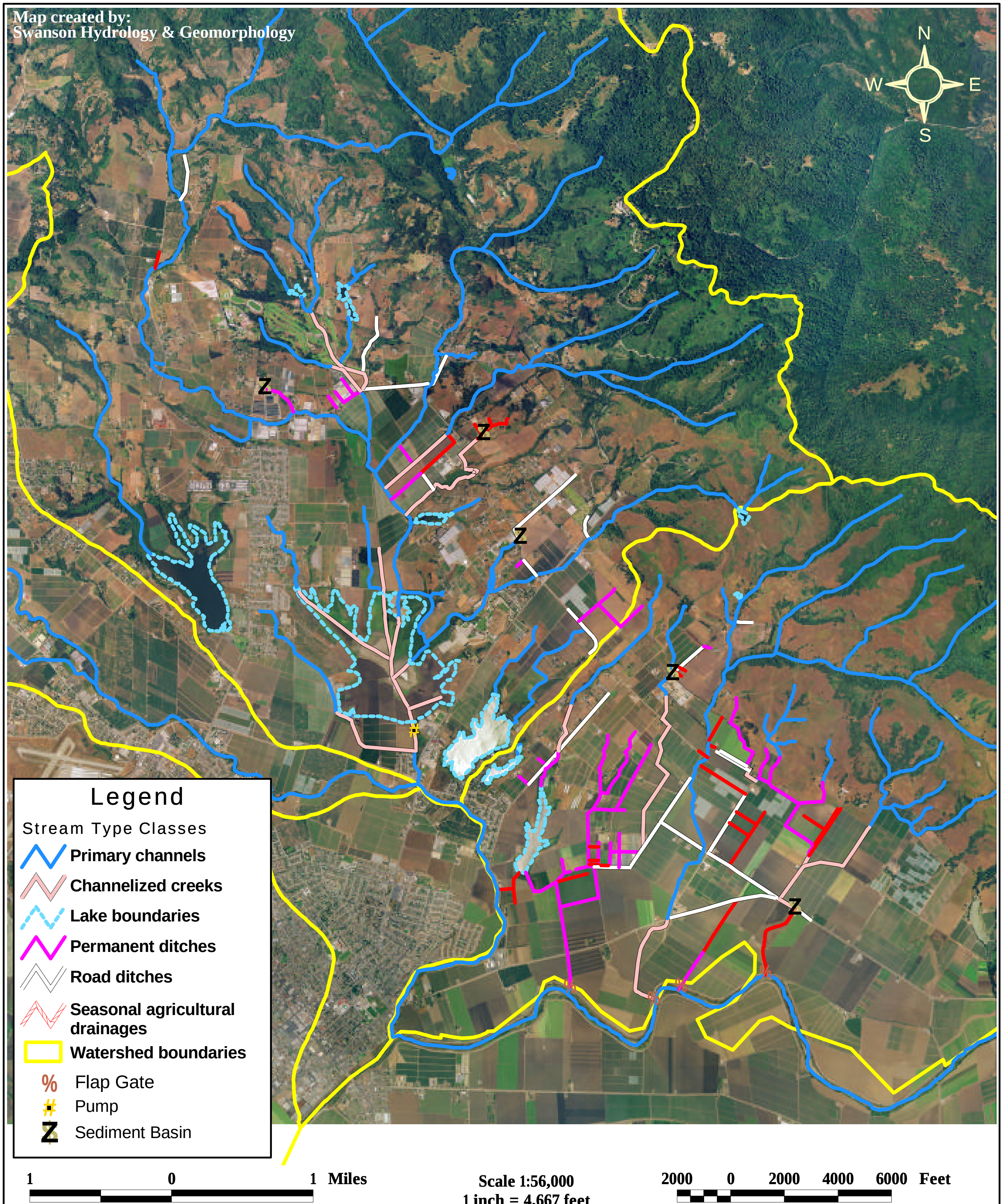
The Casserly Creek Watershed consists of both mountainous and coastal plain stream reaches including Salsipuedes Creek, the mainstem of Casserly, College Lake, College East, Hughes, Spring Hills, and Green Valley Creeks.

***Salsipuedes Creek***

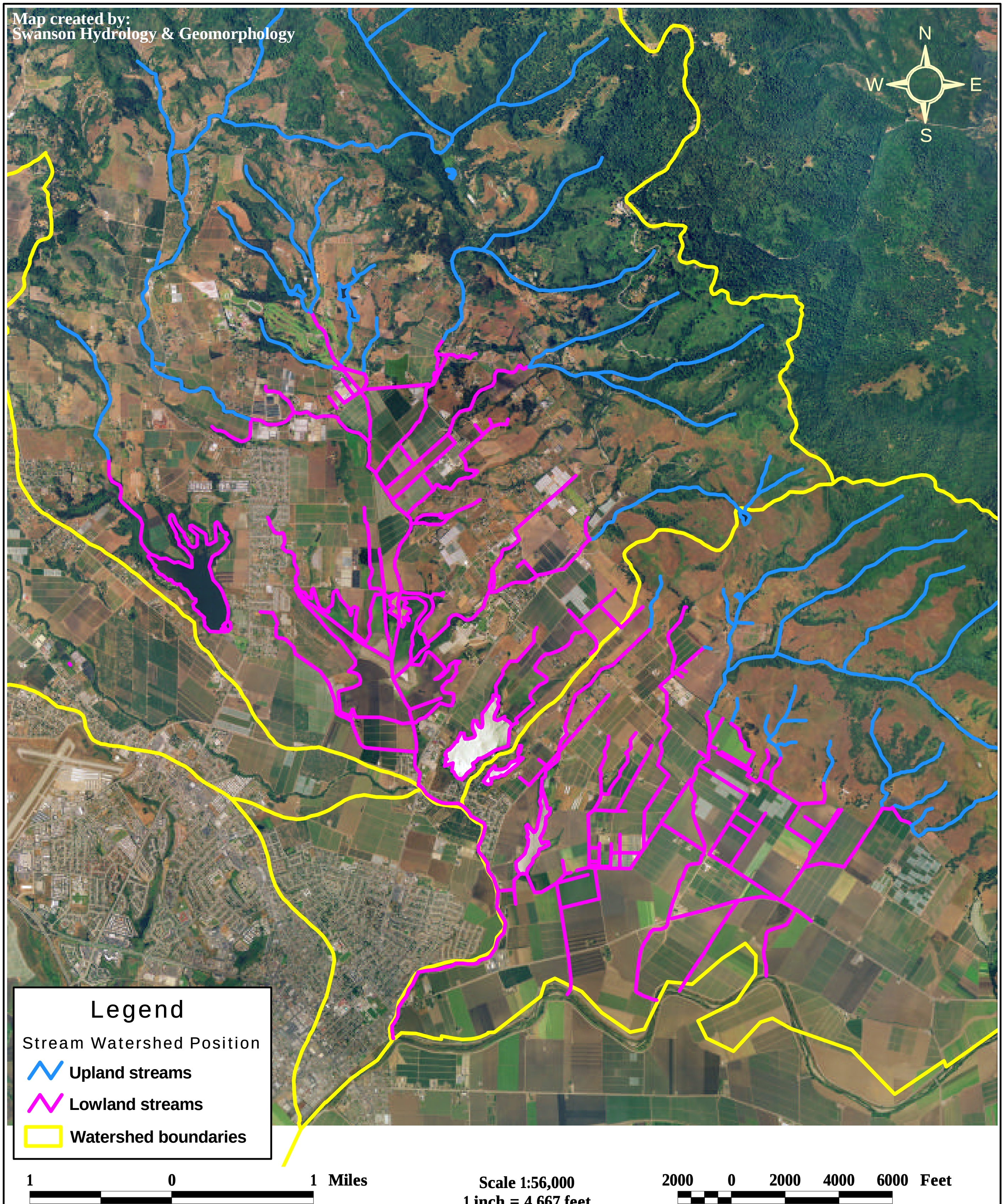
Salispuedes Creek is a perennial reach of stream that begins at the confluence of Casserly and Corralitos Creeks. It is the largest of all the streams within the study area, joining the Pajaro River in the City of Watsonville. Extensive modifications have been made to the channel and floodplain of Salsipuedes Creek, including channelizing, straightening, removal of vegetation and dredging of the channel bed. The entire length of Salsipuedes Creek is lined by an earthen levee that constricts meandering of the channel to a narrow band ranging from 50 to 100 feet. The meander bends are therefore cut off by the constriction of the channel, resulting in oversteepening and slumping of the channel banks. The lack of a well-developed riparian canopy accelerates this process of erosion.

***College Lake***

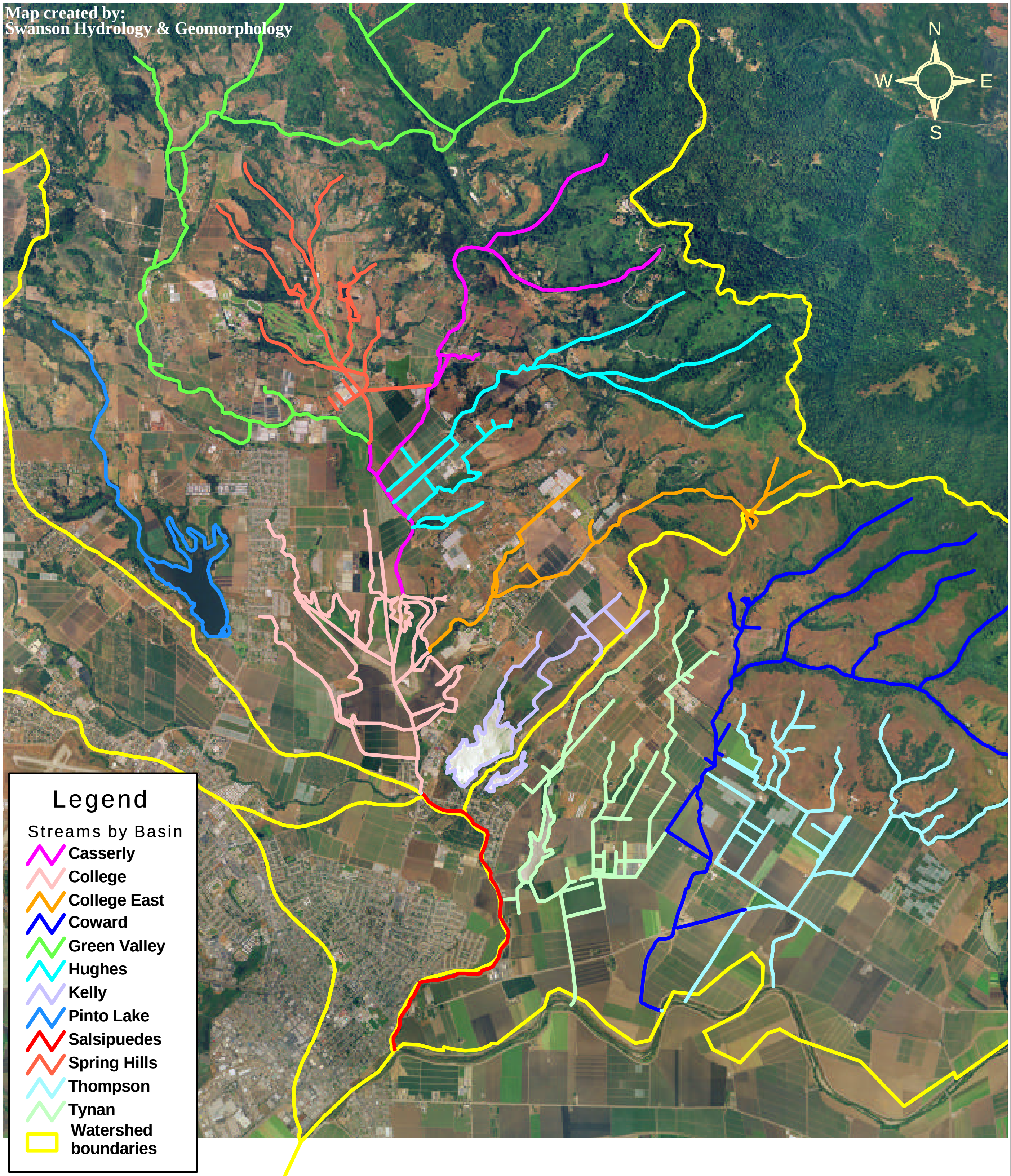
College Lake is a naturally occurring seasonal lake that is formed along the northwest-southeast trending Zayante Fault complex. The majority of the water enters from the north side of the lake through Casserly Creek. In high flow years the lake surface will be inundated and subsequently removed through a pumping system installed near the lake outlet, which conveys water downstream to Corralitos-Salsipuedes Creek. This is done to allow seasonal use of the lakebed for agriculture and grazing.




| Lower Pajaro Valley Proper Functioning Condition Assessment | **Stream Type Classes** Channel types found in the Lower Pajaro Valley range from relatively undisturbed conditions in the upper watersheds to heavily managed or completely modified channels found along lower gradient reaches on the valley floor. | Figure 2.2 |
|---|---|---|




| | | |
|---|---|---|
| **Lower Pajaro Valley Proper Functioning Condition Assessment** | **Stream Watershed Position**<br>Stream channels occurring in upland and lowland reaches of the Lower Pajaro Valley typically require different approaches to enhancement and maintenance. | **Figure 2.3** |




1 0 1 Miles

Scale 1:56,000
1 inch = 4,667 feet

2000 0 2000 4000 6000 Feet

| Lower Pajaro Valley Proper Functioning Condition Assessment | **Streams by Basin Name**<br>Channels belonging to the same watershed are grouped by line color, using different shades to show the high number of discrete basins in the Lower Pajaro Valley. | **Figure 2.4** |
|---|---|---|

| Basin | Total Stream Length | Stream Type | | | | | | | | | | | | Watershed Position | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Primary Channel | | Channelized Creek | | Lake | | Permanent Ditch | | Road Ditch | | Seasonal Agricultural Ditch | | Coastal Plain | | Mountainous | |
| | | **miles** | **%** | **miles** | **%** | **miles** | **%** | **miles** | **%** | **miles** | **%** | **miles** | **%** | **miles** | **%** | **miles** | **%** |
| Casserly | 6.3 | 6.1 | 96 | - | - | - | - | - | - | 0.2 | 4 | - | - | 2.9 | 46 | 3.4 | 54 |
| College | 13.7 | 3.8 | 28 | 3.7 | 27 | 6.3 | 46 | - | - | - | - | - | - | 13.7 | 100 | - | - |
| College East | 5.5 | 4.2 | 76 | - | - | 0.3 | 5 | 0.1 | 1.2 | 1.0 | 17 | - | - | 3.2 | 57 | 2.4 | 43 |
| Coward | 15.1 | 12.6 | 83 | 0.8 | 5 | 0.1 | 1 | - | - | 1.3 | 9 | 0.3 | 2 | 4.0 | 26 | 11.2 | 74 |
| Green Valley | 14.3 | 13.6 | 95 | - | - | - | - | 0.3 | 2.1 | 0.3 | 2 | 0.1 | 1 | 1.7 | 12 | 12.6 | 88 |
| Hughes | 8.9 | 5.2 | 59 | 1.6 | 18 | 0.6 | 7 | 0.4 | 4.8 | 0.1 | 1 | 0.8 | 9 | 4.8 | 54 | 4.1 | 46 |
| Kelly | 5.9 | 1.7 | 29 | - | - | 3.0 | 51 | 0.8 | 13.0 | 0.4 | 7 | - | - | 5.9 | 100 | - | - |
| Pinto Lake | 5.6 | 2.0 | 35 | - | - | 3.7 | 65 | - | - | - | - | - | - | 4.5 | 79 | 1.2 | 21 |
| Salsipuedes | 2.6 | 2.6 | 100 | - | - | - | - | - | - | - | - | - | - | 2.6 | 100 | - | - |
| Spring Hills | 8.1 | 4.6 | 57 | 1.0 | 13 | 1.1 | 13 | 0.5 | 5.8 | 0.9 | 11 | - | - | 2.4 | 29 | 5.7 | 71 |
| Thompson | 13.5 | 4.7 | 35 | 1.3 | 10 | - | - | 2.5 | 18.4 | 1.9 | 14 | 3.1 | 23 | 9.1 | 67 | 4.4 | 33 |
| Tynan | 13.4 | 2.0 | 15 | 1.6 | 12 | 1.7 | 12 | 5.5 | 41.0 | 1.8 | 13 | 0.9 | 7 | 12.9 | 97 | 0.5 | 3 |
| **TOTALS** | **113.1** | **63.2** | **56** | **10.0** | **9** | **16.7** | **15** | **10.0** | **8.9** | **7.9** | **7** | **5.2** | **5** | **67.7** | **60** | **45.4** | **40** |

Table 2.3. Stream and Watershed statistical summary

The presence of a lake at this location in the system provides both storage of water and a sink for much of the sediment being generated upstream of College Lake. The location and extent of sediment deposition changes with lake level, creating unstable channel conditions at the upstream end of the lake. In the past, non-storm flows were confined to a heavily vegetated channel in the northeast corner of the lake. In recent years, the stream has cut a new path through the center of the lake, the cause of which is not clear.

Since this area of the lake is experiencing high sediment deposition, it is likely the channel will continue to form and reform with each major flow event. This is a fairly common condition at the head of seasonal lakes or reservoirs.

***College East***

College East consists of an unnamed drainage flowing into the eastern end of College Lake. The lower stream reaches in the vicinity of College Lake are experiencing high sediment loads and aggradation of the primary channel, similar to the impacts occurring in the northern section of College Lake. The source of the sediment can be found in the upper watershed, where slumping of fine-grained soils and the streambanks result from movement along the San Andreas Fault Zone. Lack of floodplain sediment storage due to narrowing and straightening of the channel through the Carlton Road/Hecker Pass reaches have accelerated sediment transport to the lower reaches.

***Casserly and Hughes Creek***

These two drainages have similar hydrologic and geologic properties. The upper watershed consists of steep, heavily forested canyons, broken by rangeland that occurs on the ridges. The watersheds consist mainly of mountainous stream channels with intact riparian corridors dominated by alder and redwood. Though there are significant sediment sources from landslides, roads, and other smaller sources, the delivery of fine-grained sediment to the stream channels is not as problematic and chronic as conditions to the south and east.

The lower reaches of Hughes Creek consists of highly channelized and straightened sections. Lower Casserly, down to College Lake consists of vegetated and unvegetated segments that have incised into the valley floor. This incision of the stream channel may be partly due to loss of floodplain due to encroachment and increased storm runoff due to land conversion.

***Spring Hills***

The Spring Hills watershed consists of a highly dissected landscape that falls completely within the San Andreas and Corralitos Fault Zones. Narrow alluvial valleys occur between steep, highly erodible hillslopes. The presence of flat alluvial valleys adjacent to steep hillslopes suggests periodic massive landslides and debris flows that fill the valley floor. Much of the alluvial fill that Spring Hills Golf Course sits on was developed in this manner. Heavy sedimentation of small reservoirs in the watershed gives additional evidence of high sediment loads.

Many of the alluvial valleys and streams in this watershed have been impacted by road development up the valley floor and relocation, channelization and straightening of streams. This is especially evident within Spring Hills Golf Course where historic channel alignments have been altered to accommodate fairways and cart paths.

***Green Valley***

The Green Valley watershed is the largest and most diverse drainage in the study area consisting of low-gradient, meandering channel patterns, upland valleys, and steep, forested canyons.

The steep upper-watershed canyons drain into Hazel Dell Valley, which is a low-gradient upland valley, formed parallel to movement on the San Andreas Fault Zone. This valley has been filled by landslide and debris flows, trapping and attenuating sediment contributions to lowland streams and valleys. The heavily forested canyons also contain roughness elements such as large woody debris and log jams that act to store delivered sediment.

Downstream of Hazel Dell Valley, Green Valley Creek is a steep, coarse-bedded, bedrock controlled channel typical of other similarly sized streams draining the Santa Cruz Mountains. Once it reaches the lowland the channel becomes low gradient and develops a meandering pattern through the alluvial valley. It is through these areas that the creek begins to experience impacts from channel downcutting and heavy bank erosion. Increased runoff from land use changes and urbanization of the watershed contribute to this problem.

### 2.6.3. Coward Creek Watershed

The Coward Creek watershed is the principal waterway draining the southeastern portion of the study area. It consists of a primary stream channel that flows through the coastal plain with most of the drainage area occurring in the mountainous portion of the study area, as shown in Figure 2.4.

The upper reaches of the mountainous portion of the Coward Creek watershed consists of four primary streams that consist of steep, heavily vegetated channels: Cummings Creek, Kinky Creek, Mill Creek and Arano Creek. At the upper end of the watershed, Mill and Arano Creeks flow into the mainstem of Coward Creek, which consists of a relatively low gradient valley that runs parallel to the San Andreas Fault Zone. This valley functions as a zone of sediment deposition that is delivered to the channel from high gradient tributary reaches, as evidenced by the presence of the alluvial valley and stream banks consisting primarily of fine-grained sediment.

Downstream of the low-gradient valley, the mainstem of Coward Creek steepens and narrows as it cuts across the trend of the San Andreas Fault Zone. Active slumping and landsliding occurring on the north side of the watershed impinge upon the channel, delivering fine-grained sediment to the stream and increasing the force of the flow on the steep south banks. The result is periodic massive landsliding of the south bank that can cause debris flows downstream. A recent landslide/debris flow was reported to have resulted in extensive bank erosion and gullying on lower Coward Creek during the heavy rains of 1998.

The stream reaches in this watershed that occur within the coastal plain are experiencing two very different sediment conditions that can roughly be divided at Carlton Road. Upstream of Carlton Road, significant downcutting and bank erosion is occurring, especially near the upper part of the stream reach near the contact of the mountainous and coastal plain reaches. Downstream of Carlton Road sediment from eroding upstream reaches and upper watershed hillslope contributions have resulted in aggradation of the main channel. Over time, this has prompted the County of Santa Cruz to periodically dredge and raise adjacent levees that have caused the current channel elevation to be higher than the surrounding farmland. A flap gate at the mouth of Coward where it flows into the Pajaro River may also be contributing to heavy sedimentation during high flow years due to backwatering.

### 2.6.4. Kelley Lake Watershed

Kelley Lake is a small watershed that primarily drains the coastal plain between Tynan Lake and College East. Streams draining this watershed end at Kelley Lake and do not appear to have an outlet. Kelley Lake was formed along the Zayante Fault, similar to the formation of Pinto, College, and Tynan Lakes. Kelley Lake acts as a water storage and recharge area for the Pajaro Valley but may have been drained and farmed in the past.

Due to the lack of access of the Kelley Lake Watershed, very few of the stream reaches were assessed and therefore, the overall geomorphic condition of the Kelley Lake watershed is not well understood. Based on a limited number of site visits, the stream appears to consist of small, incised channels with steep banks consisting of fine-grained sediment. Some vegetation does exist on the banks, adding some stability, though the overall channel stability is low.

### 2.6.5. Tynan-Martin Watershed

The Tynan-Martin Creek watershed is a larger version of the Kelley Lake watershed where most of the drainage area occurs on the coastal plain. Past and current land use practices have greatly altered the drainage patterns of the Tynan Lake watershed with many channels being straightened, ditched, seasonally farmed and lined with levees. Tynan Lake has water a majority of the time and acts as a groundwater recharge basin for the Pajaro Valley.

Erosion of channelized ditches and adjacent hillslopes appears to be severe in this watershed as evidenced by channel aggradation occurring in several locations throughout the watershed. The Tynan-Martin Creek watershed has essentially become a highly modified system of straightened channels and agricultural and roadside ditches. Consequently, the channels are experiencing substantial bank instability and erosion.

### 2.6.6. Thompson Creek Watershed

The Thompson Creek watershed is dominated by coastal plain stream reaches that have been highly modified by agricultural and land use practices. Unlike Tynan Lake watershed, there is a considerable portion of the upper watershed that occurs within the mountains. These reaches provide a considerable amount of fine-grained sediment from steep and highly erosive hillslopes that have a considerable impact on the lowland waterways.

High sediment loads, combined with low-gradient waterways in the lower reaches of the stream that are inefficient at moving sediment, resulting in chronic flooding and yearly maintenance of culverts and drainage ditches.

# 3. EXISTING CONDITIONS ASSESSMENT

## 3.1. Upland Assessment Method

The assessment of lands within the study area was facilitated by a number of concerned and interested landowners or managers within the various subareas. There was no expectation or attempt to be 'complete' in this assessment approach. The focus of this assessment phase was on agricultural lands and, due to time constraints, the assessment could not effectively include rural residential properties. For the most part, the accessibility and cooperation of owner/managers dictated the areas assessed. Seasonal time constraints for the assessors and growers also limited access and coverage. In some cases, where particularly severe or unique problems exist, additional effort was made to contact and visit with as many owner/managers in these areas as possible.

Typically initial contact was made by Santa Cruz County Resource Conservation District (SCCRCD) staff with a follow-up call and appointment made by the assessment leader. An assessment form was used as a general outline for each interview (see Appendix D). However, it was found to be too cumbersome for use during field interviews and was largely used to 'download' field notes or observations from memory immediately following each visit.

After introductions and review of the rationale for this assessment project, each owner/manager was encouraged to provide their perspectives on drainage and sedimentation issues in their neighborhood(s). Often the discussions that ensued touched on local history, recent changes in land use, past-present relationships with neighbors, key agencies and departments, as well as, current problems, management practices, and/or desired solutions to problems. Dependent upon the size of the properties, walking or driving tours were made to cover as much of a given area as possible. The assessment leader attempted to identify every critical water, soil, and/or vegetation management practice or structure. In some cases it was found that critical drainage structures were no longer in use or forgotten, due to changes in ownership, tenancy, or land use.

Site visits with owner/managers ranged in length from 30 minutes to over 4 hours. Short summaries generally describing the property, uses, applicable soil and water management practices/structures is presented in Appendix E.

Approximately 8,750 acres (~37 percent) within the project area were covered as part of the assessment phase. Much of the assessed acreage resulted from visits to the three largest upland ranches in the region that account for approximately 6,050 acres. Each of these large ranches occupies more than one subarea. No site assessments were made in the Salsipuedes, Spring Hills, and Pinto Lake subareas due to schedule constraints. The remaining approximately 2,700 acres assessed were largely in the lowland portions of subareas where vegetable, berry, flower, nursery and apple production were the most common land use.

## 3.2. Stream and Riparian Corridor Survey Assessment

### 3.2.1. Overview

The stream and riparian survey assessment portion of the this study includes several elements aimed at depicting existing and potential future conditions within the study watersheds related to riparian vegetation, channel stability, bank conditions, and erosion and sedimentation impacts. The initial assessment included development of GIS map layers describing general channel characteristics such as stream type, position and location. Once the initial GIS database was assembled, site-specific information about riparian corridor and channel conditions was generated for the watershed at a reconnaissance level.

In order to assess channel and bank impacts, the selected method needed to provide quantifiable and comparable estimates of erosion conditions. The method also needed to incorporate measured physical parameters that not only describe existing erosion problems but future problems. Understanding existing and potential impacts is a key element in generating a list of treatments and management alternatives.

### 3.2.2. Methods

***GIS Map Layers***

All GIS layers were digitized from a 1-meter pixel color aerial photo of the Pajaro Valley provided to the project by AirPhotoUSA. The layers developed for the project include stream centerlines and other points of interest.

***Stream Layer***

Attributes for the stream layer include stream type, position, and location. Stream type was classified through a combination of aerial photo analysis and fieldwork according to the dominant hydrologic function of the channel.

Identified stream types within the study area include primary channels, channelized creeks, lake boundaries, permanent agricultural ditches, road ditches and seasonal agricultural ditches is presented in Figure 2.2. An initial determination was made between agricultural and road ditches and streams. The streams category was delineated further into primary channels and channelized creeks. Channelized creeks were defined as streams that have been highly modified through relocation or straightening.

The position attribute differentiates between streams that occur on the coastal plain and those that occur within the mountainous region, as shown in Figure 2.3. A geologic map of the region was used to differentiate stream position. Streams that occur on extensive alluvial deposits that dominate the lowland were classified as coastal plain streams. If a stream occurs on other geologic formation they were classified as mountainous.

The location attribute defines each stream within a particular subwatershed, as shown in Figure 2.4. This attribute is mainly used as a tool to group streams within a watershed context to assist discussion. Most watersheds were named for the primary stream flowing through them while other subwatersheds, such as Spring Hills and Kelley, were named according to a dominant feature occurring within the subwatershed

***Points of Interest***

The features mapped for this layer include pump stations, sediment basins and flap gates, as shown in Figure 2.2.

The data layers presented in this report represent the best available information given the resources available and do not include all drainage features and points of interest present within the study area. Additional features may occur within the study area including small headwater streams, agricultural and road ditches, and sediment basins.

***Riparian Vegetation***

Riparian vegetation conditions on streams within the Lower Pajaro River study area were assessed using several methods. A color aerial orthophoto (flown in June 2000) was used to review general watershed conditions and status of riparian vegetation on streams within the lower and upper watershed areas. Specific portions of the photo were enhanced and enlarged on the computer in order to assess specific area conditions and determine general vegetation conditions for areas that could not be visually surveyed from public access points. An initial reconnaissance-level field visit was conducted with Swanson Hydrology staff on 4/25/01 to review vegetation on lowland streams within the study area. A second and third field survey occurred on June 22 and 23 to more closely inventory riparian vegetation from public access points (usually road crossings) and ground truth aerial photos. All lowland streams were inventoried during the June field visits. A field reconnaissance on the upland portion of Coward Creek (Kelly-Thompson Ranch) was accomplished on 5/8/01, and a site visit to a portion of the Estrada Ranch (Upper Green Valley Creek) was conducted by J. Gilchrist for another project in spring, 2000. Other than these two site visits, upland riparian habitat conditions were determined by review of aerial photos. The narrative evaluation of riparian vegetation is based on the field and aerial photo review, as well as review of extensive field notes taken by Swanson Hydrology staff during their inventory of hydrology conditions. No focused surveys for sensitive plants or animals were conducted for this assessment.

***Streambank Erosion Potential***

Streambank erosion potential was determined at accessible points on coastal plain streams within the Lower Pajaro study area using a method developed by Rosgen (1996). The Rosgen method is based on the assumption that the ability of streambanks to resist erosion is primarily determined by:

- The ratio of streambank height to bankfull or channel forming flow stage
- The ratio of riparian vegetation rooting depth to overall streambank height
- The degree of rooting density
- The composition of streambank materials
- Streambank angle
- Bank material stratigraphy and presence of soil lenses
- Bank surface protection afforded by debris and vegetation

Based on these assumptions and measured field information, the Rosgen method classifies reaches of streambank into relative bank erosion potential (e.g. – very low, low, moderate, high, very high, and extreme) providing an index to compare conditions throughout the study area. Relative bank erosion potential is determined according to the five measured criteria, the values of which are converted to an index, as shown in Table 3.1.

To obtain the necessary information to determine the index values for each criterion, each site was field surveyed. The measured parameters were flow distribution, erodibility, bankfull width, depth at two-times bankfull width, overall bank height, bankfull height, sinuosity, bank angle, percent bank face protected, percent root density, rooting depth from top of bank, bank material particle size, bank material sorting, bank soil stratification, streambed material, and stream gradient. The stream reach that exhibited similar characteristics to the survey location was assessed through fieldwork and analysis of aerial photos. During the survey, locations and description of active and severe erosion problems and sedimentation were noted.

Each field parameter was determined for homogeneous stream and bank segments (reaches). Bank parameters were determined for left and right banks (looking downstream) separately.

Table 3.1. Bank Erodibility Hazard Rating Guide(adapted from Rosgen, 1996)

| Bank Erosion Potential | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | Very Low | | Low | | Moderate | | High | | Very High | | Extreme | |
| | Value | Index | Value | Index | Value | Index | Value | Index | Value | Index | Value | Index |
| Bank Height / Bankfull Height | 1-1.1 | 1-1.9 | 1.1-1.19 | 2-3.9 | 1.2-1.5 | 4-5.9 | 1.6-2 | 6-7.9 | 2.1-2.8 | 8-9 | > 2.8 | 10 |
| Root Depth / Bank Height | 1-0.9 | 1-1.9 | 0.89-0.5 | 2-3.9 | 0.49-0.3 | 4-5.9 | 0.29-0.15 | 6-7.9 | 0.14-.05 | 8-9 | < 0.05 | 10 |
| Root Density (%) | 80-100 | 1-1.9 | 55-79 | 2-3.9 | 30-54 | 4-5.9 | 15-29 | 6-7.9 | 5-14 | 8-9 | < 5 | 10 |
| Bank Angle (Degrees) | 0-20 | 1-1.9 | 21-60 | 2-3.9 | 61-80 | 4-5.9 | 81-90 | 6-7.9 | 91-119 | 8-9 | > 119 | 10 |
| Surface Protection (%) | 80-100 | 1-1.9 | 55-79 | 2-3.9 | 30-54 | 4-5.9 | 15-29 | 6-7.9 | 10-15 | 8-9 | < 10 | 10 |
| Totals | | 5 – 9.5 | | 10-19.5 | | 20–29.5 | | 30–39.5 | | 40–45 | | 46-50 |
| Bank Materials: Bedrock: Bank erosion potential always very low<br>Boulder: Bank erosion potential low<br>Cobble: Decrease by one category unless mixture of gravel/sand is over 50%, then no adjustment<br>Gravel: Adjust total index values up by 5-10 points depending on composition of sand<br>Sand: Adjust total index values up by 5-10 points<br>Silt/Clay: No adjustment<br>Stratification: 5-10 points (upward) depending on position of unstable layers in relation to bankfull stage | | | | | | | | | | | | |

Upper watershed, mountainous stream reaches were not assessed using the Rosgen methodology due to limited stream access points and the total number of stream reaches that occur within the study area. Instead, as many streams as possible were assessed qualitatively based on landowner cooperation and available time. Notes were made regarding the general conditions of the channels, grain sizes of the bed material and problematic erosion sites.

### 3.3. Overview of Assessment Results

Erosion and sedimentation problems occur in all parts of the study area, however, there are a few areas where these problems are particularly acute and are due to a complexity of factors.

In general, land use the upper watershed areas have been under similar uses and management for the past century and few problem areas are present. In these areas there is little access to seasonal creeks by livestock, although there are very few areas with riparian fencing.

Bank instability, removal and/or loss of riparian vegetation are more common in the lowland areas, where many recent land use changes have and are occurring. In general there appears to be more obvious problems in areas with a greater percentage of the land areas used for row crop vegetable and berry production. The continued conversion of orchards to row crop production, increases in impervious surfaces and runoff.

Additional factors, such as an increase in rural residential development, poorly coordinated maintenance of drainage infrastructure between public and private sectors, and permitting issues are common themes where significant problems exist in the study area.

#### 3.3.1. Land Use Conversion and Drainage

In general, the drainage infrastructure (e.g. roadway ditches, agricultural ditches, and channelized creeks), in many areas are less than adequate to convey runoff given the amount of development and conversion of agricultural lands in the past two decades. As a result there are increasing problems with localized flooding and sedimentation, collapse of road shoulders, failure of drainage ditches, and increased instability of creek channels and riparian vegetation.

Over the past 15 years, the reduction of apple acreage has continued, particularly on the nearly level soils of the valley floor. These lands have most often been converted to row crop acreage that has dramatically changed the nature and volume of drainage water from these lands. While strawberry and bush berry production has increased, much of the new berry production acreage is being developed on foot slope areas on lands with slopes of greater than two percent, where erosion risks are generally higher. The change in land use from permanent orchards has perhaps had the most significant impact on drainage infrastructure and sedimentation in certain portions of the study area. Increases in rural residential development are also leading to increased surface runoff. As with agricultural drainage, most of the increased runoff from residential development may be directed to roadway ditches and/or creeks.

Generally, the study found numerous problems, primarily in the lowlands areas, related to the lack of coordinated maintenance or enhancement efforts between owner/managers and County or State departments. Another common problem, related to changes in agricultural land use, are practices and/or structures adopted by one owner/manager that have led to or have compounded ‘downstream’ problems for another owner/manager. As mentioned previously, we also have noted that recent land use changes, particularly conversion of apple orchards to cane- or strawberry production, have led to increasing localized sedimentation. In these areas we often found that pre-existing drainage infrastructure, whether private or public, was not adequate to handle either increased runoff volumes and/or velocities.

#### 3.3.2. Riparian Corridors

A substantial percentage of lowland streams in the study area have little or no native riparian vegetation due to plant removal by herbicide or mechanical means, or channel relocation to the edges of farm fields or property boundaries. Where riparian vegetation is absent or where native species have been replaced by shallow-rooting non-native ruderal (weedy) species, there is little protection against bank slope failure and significant erosion. Stream reaches with a mature riparian vegetation canopy and a relatively complete native or non-native understory generally have relatively intact streambanks, although stream downcutting may be occurring due to unstable conditions up or downstream.

Upper watershed stream reaches were not surveyed as thoroughly as lowland reaches. However spot surveys and aerial photo review indicate that native riparian trees and shrubs are present on most channel banks, particularly in upper watershed areas, where grazing or timber harvesting are the predominant the predominant land uses. Many areas also have a well vegetated riparian buffer that ranges from 10 to 50 feet on each side of the channel at the top of bank. A much larger proportion of the riparian understory is native herbs, shrubs and immature riparian trees, than is present on lowland stream reaches. This type of stratified riparian community, with three to four canopy levels, provides significant erosion protection for streambed and banks.

The upper watershed above Hazel Dell Road is well vegetated with redwood and willow. Below Hazel Dell, the almost continuous riparian canopy is interspersed with small, partially cleared areas that are usually adjacent to rural home sites and corrals. The riparian tree canopy consists of willow, cottonwood, and alder with eucalyptus clustered in some areas. Several areas spot-surveyed in the Green Valley Rd.- Sans Rd.-Fitchfield Lane vicinity have a good willow-alder-redwood canopy, but only 30 to 50 % of the bank face is protected with vegetation. Downstream near the Wheelock-Casserly Rd. intersection canopy cover and bank vegetation increased slightly with an oak, alder and willow overstory and poison oak, German ivy and willow seedling understory.

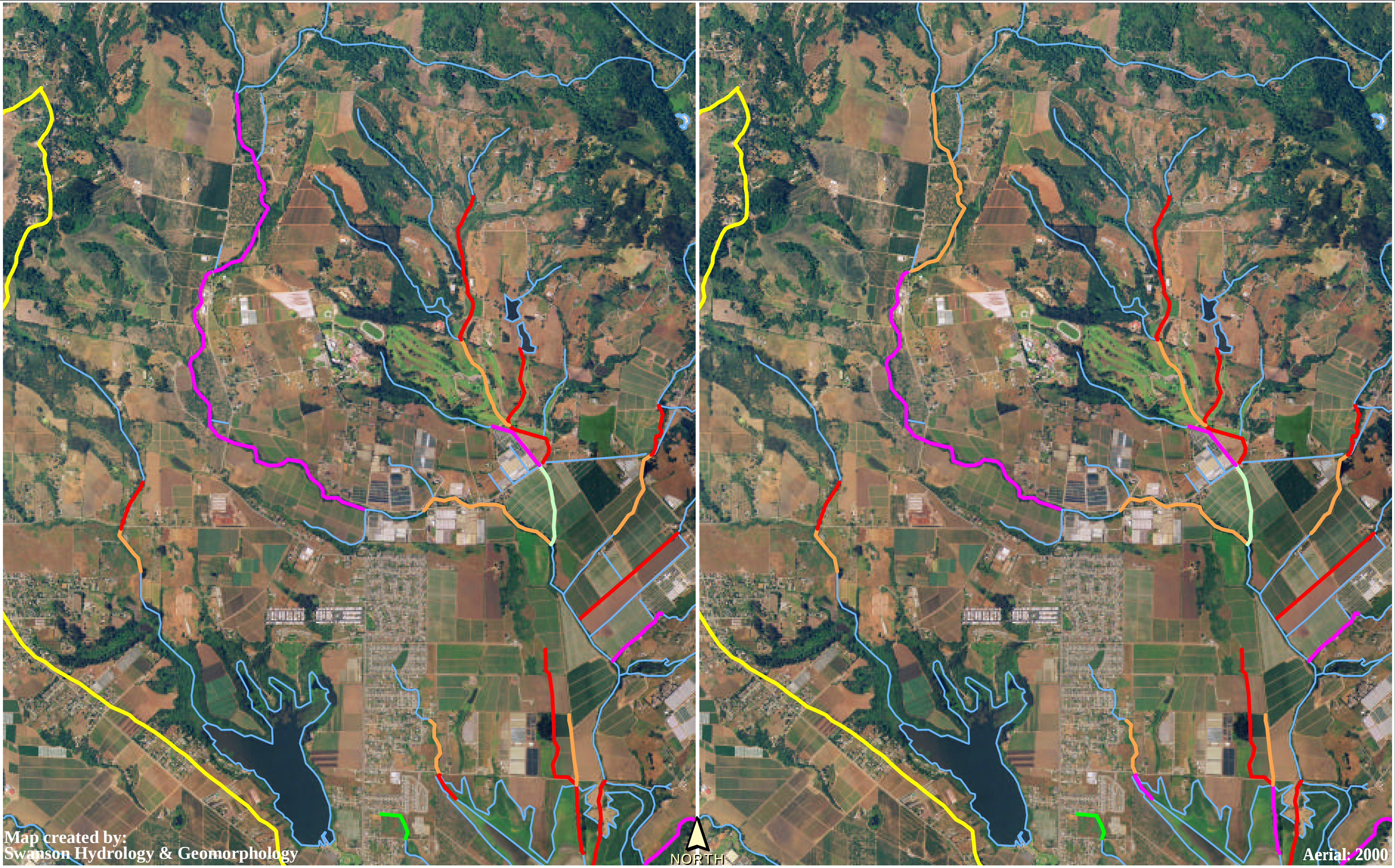
### 3.3.3. Stream Bank and Channel Conditions

The erosion potential for stream banks has been mapped for the each stream studied and is presented in Figures 3.1through 3.4 and summarized in Table 3.1. Approximately 35% of the stream reaches within the coastal plain where characterized, with some subwatersheds receiving high or lower percentages, based on access.

In general, the results from the stream bank and channel study suggest that most of the coastal plain stream reaches either are, or have a high potential of experiencing significant bank erosion due to the present condition of the banks. This is the result of several factors: downcutting and bank steepening due to increased runoff; narrowing of the channel to maximize agricultural production, and loss and/or removal of riparian vegetation that support the banks. Natural bank instability also exists within the project area due to the presence of fine-grained sediment that is the predominate grain-size and highly erodible. Stream reaches in that are experiencing low bank erosion are often reaches that are vegetated, aggrading (filling), have low bank height and or mild side slope angles, such as Salsipuedes or Spring Hills streams. Other streams, such as Green Valley and Casserly creeks, have intact riparian corridors but are experiencing downcutting (channel incision) and loss of bank stability in certain reaches. The result is a high potential for erosion and loss of established riparian vegetation, as the banks become undermined. This may be attributed to several factors including the lowering of the shallow groundwater, channelization, and increased runoff from upland areas.

Results for the mountainous reaches are not as easily quantifiable. Accessible survey locations were assessed for the upper watersheds of Green Valley, Casserly, Coward and Thompson Creek. The results suggest a gradient in conditions from southeast to northwest within the study area. Channels in the southeastern part of the study area and within the upper watershed of Coward Creek consist of fine-grained sediment and experience constant and extensive landsliding and slumping.

left bank | banks determined by looking downstream | right bank




1 0 1 Miles

Scale 1:40,000
1 inch = 3,333 feet

5000 0 5000 Feet

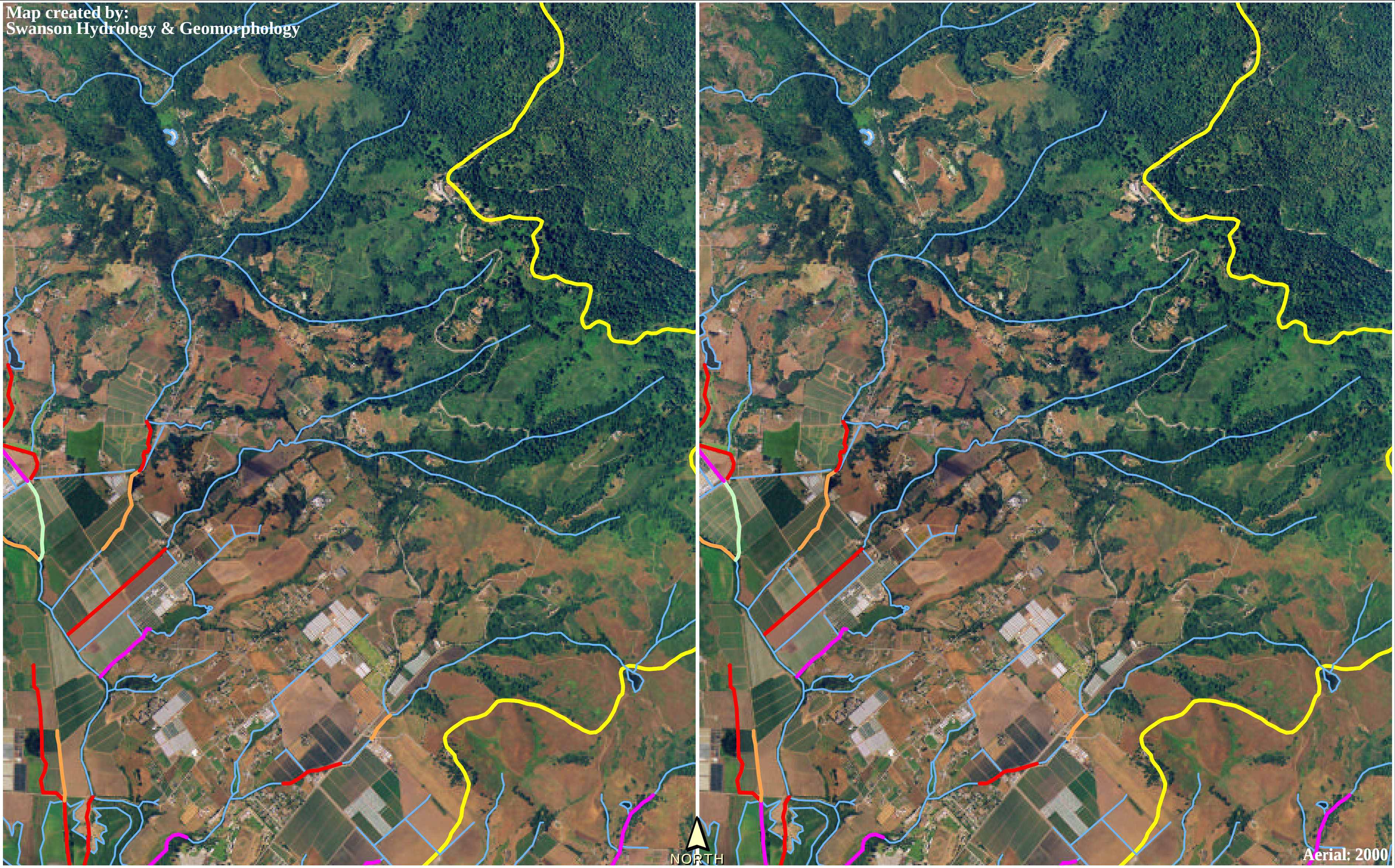
**Lower Pajaro Valley Proper Functioning Condition Assessment**

**Erosion Potential for Stream Banks in the Pinto, Green Valley and Spring Hills Basins**

Extreme
Very High
High
Moderate
Low
Other Streams
Watershed Boundaries

**Figure 3.1**

left bank | banks determined by looking downstream | right bank




1 0 1 Miles

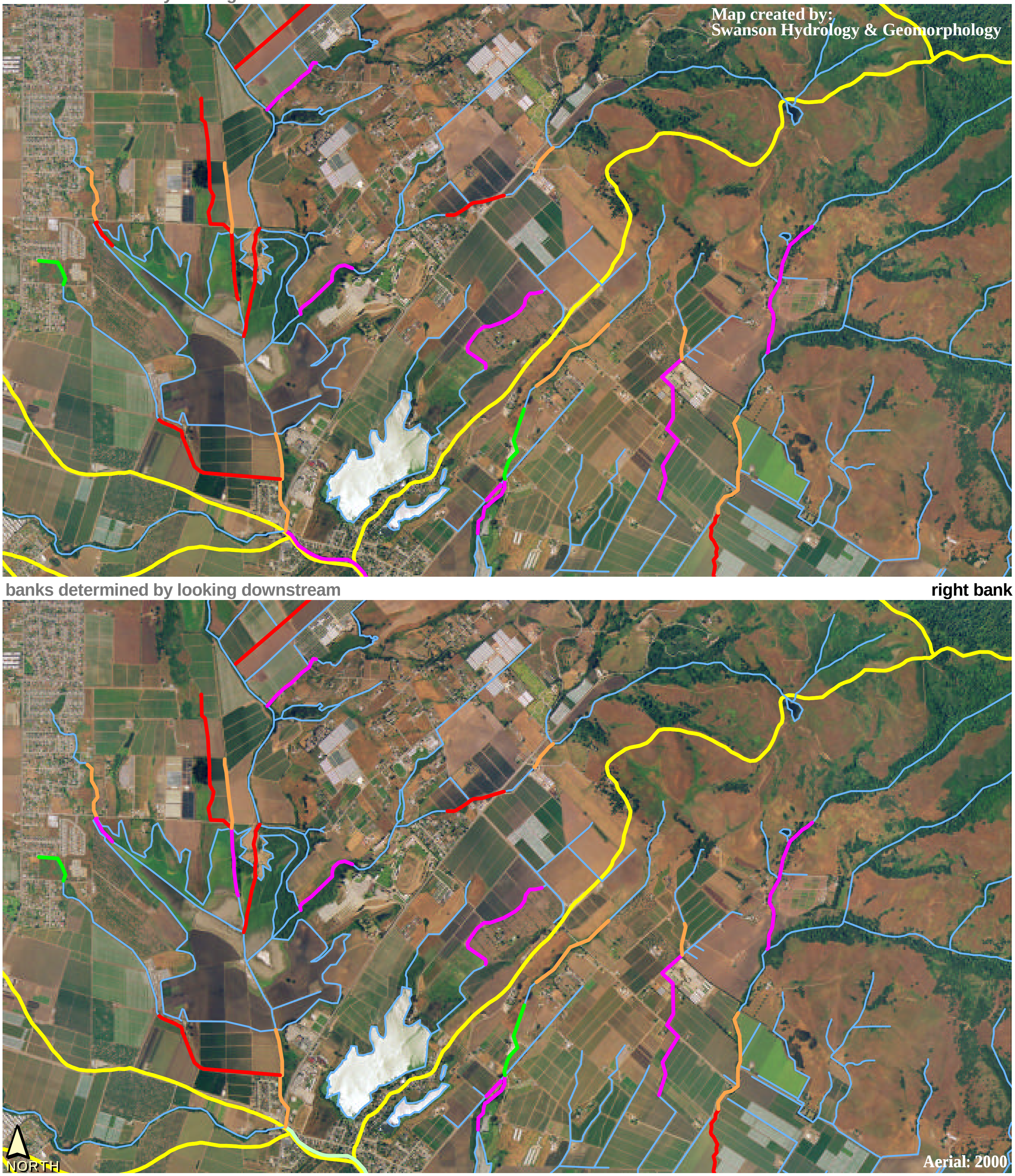
Scale 1:40,000
1 inch = 3,333 feet

5000 0 5000 Feet

| Lower Pajaro Valley Proper Functioning Condition Assessment | Erosion Potential for Stream Banks in the Casserly and Hughes Basins<br>Extreme · Very High · High · Moderate · Low<br>Other Streams · Watershed Boundaries | Figure 3.2 |
| --- | --- | --- |

banks determined by looking downstream

left bank




0.5 0 0.5 1 Miles

Scale 1:40,000
1 inch = 3,333 feet

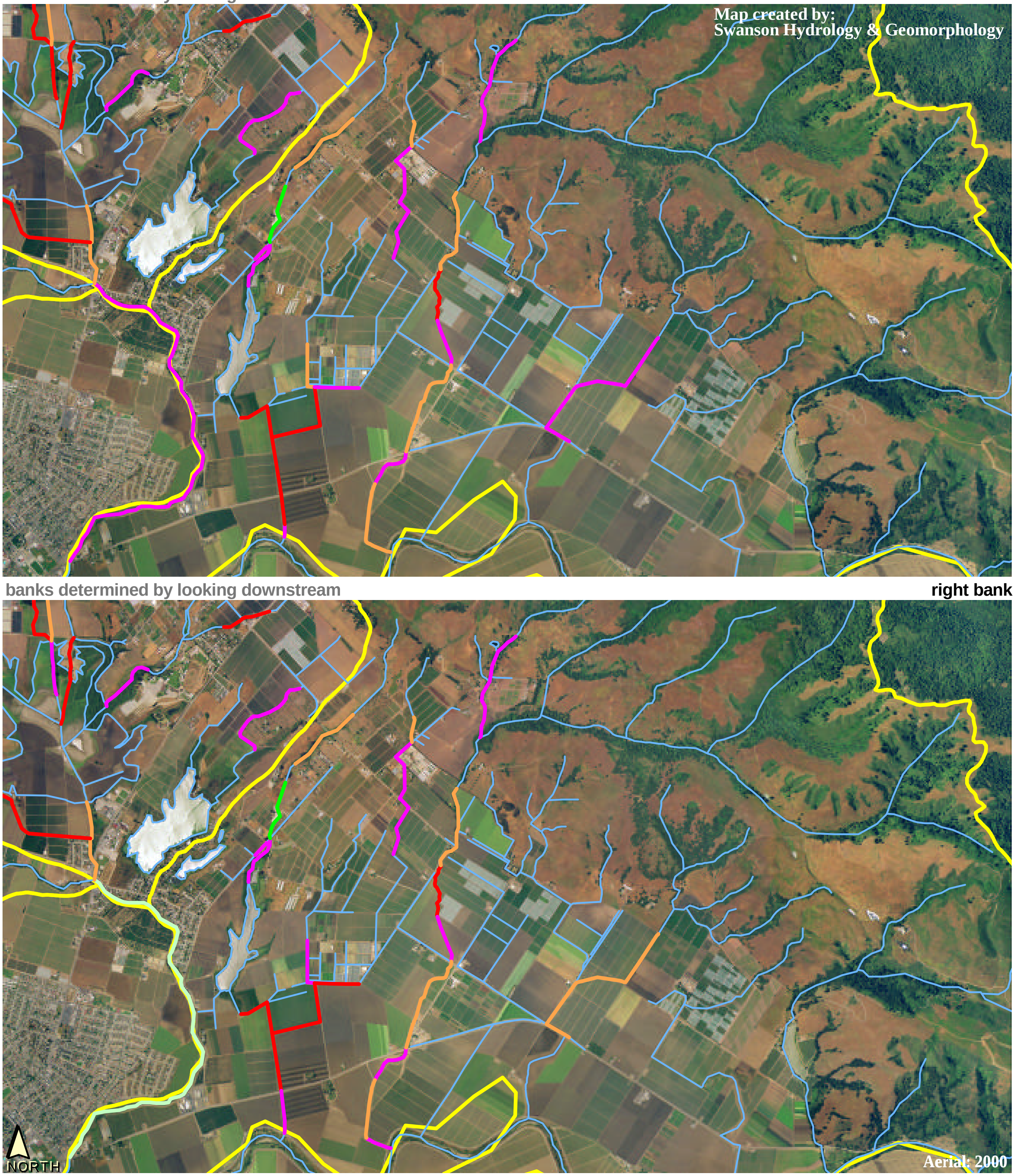
2000 0 2000 4000 Feet

| Lower Pajaro Valley Proper Functioning Condition Assessment | Erosion Potential for Stream Banks in the College, College East and Kelly Basins | Figure 3.3 |
|---|---|---|

Extreme
Very High
High
Moderate
Low
Other Streams
Watershed Boundaries

banks determined by looking downstream

left bank




1 0 1 Miles

Scale 1:50,000
1 inch = 4,167 feet

2000 0 2000 4000 6000 Feet

**Lower Pajaro Valley Proper Functioning Condition Assessment**

**Erosion Potential for Stream Banks in the Coward, Thompson, Tynan and Salsipuedes Basins**

Extreme
Very High
High
Moderate
Low
Other Streams
Watershed Boundaries

**Figure 3.4**

| Basin | Total Miles Surveyed | Right Bank Erosion Potential | | | | | | | | | | Left Bank Erosion Potential | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Extreme | | Very High | | High | | Moderate | | Low | | Extreme | | Very High | | High | | Moderate | | Low | |
| | | miles | % | miles | % | miles | % | miles | % | miles | % | miles | % | miles | % | miles | % | miles | % | miles | % |
| Casserly | 0.7 | 0.3 | 38 | - | - | 0.4 | 62 | - | - | - | - | 0.3 | 38 | - | - | 0.4 | 62 | - | - | - | - |
| College | 3.6 | 1.9 | 53 | 0.4 | 13 | 1.0 | 29 | 0.2 | 5 | - | - | 2.3 | 65 | - | - | 1.0 | 29 | 0.2 | 5 | - | - |
| College East | 0.8 | 0.3 | 36 | 0.4 | 46 | 0.1 | 18 | - | - | - | - | 0.3 | 36 | 0.4 | 46 | 0.1 | 18 | - | - | - | - |
| Coward | 3.1 | 0.3 | 10 | 1.3 | 44 | 1.4 | 46 | - | - | - | - | 0.3 | 10 | 1.2 | 39 | 1.6 | 51 | - | - | - | - |
| Green Valley | 3.3 | - | - | 1.7 | 50 | 1.6 | 50 | - | - | - | - | - | - | 2.6 | 79 | 0.7 | 21 | - | - | - | - |
| Hughes | 0.9 | 0.6 | 65 | 0.3 | 35 | - | - | - | - | - | - | 0.6 | 65 | 0.3 | 35 | - | - | - | - | - | - |
| Kelly | 0.6 | - | - | 0.6 | 100 | - | - | - | - | - | - | - | - | 0.6 | 100 | - | - | - | - | - | - |
| Pinto Lake | 0.5 | 0.2 | 51 | - | - | 0.2 | 49 | - | - | - | - | 0.2 | 51 | - | - | 0.2 | 49 | - | - | - | - |
| Salsipuedes | 2.4 | - | - | - | - | - | - | - | - | 2.4 | 100 | - | - | 2.4 | 100 | - | - | - | - | - | - |
| Spring Hills | 2.4 | 1.3 | 55 | 0.3 | 11 | 0.5 | 18 | - | - | 0.4 | 15 | 1.3 | 55 | 0.3 | 11 | 0.5 | 18 | - | - | 0.4 | 15 |
| Thompson | 1.1 | - | - | - | - | 1.1 | 100 | - | - | - | - | - | - | 1.1 | 100 | - | - | - | - | - | - |
| Tynan | 4.0 | 1.4 | 35 | 1.7 | 41 | 0.6 | 15 | 0.3 | 9 | - | - | 1.3 | 33 | 1.5 | 37 | 0.9 | 21 | 0.3 | 9 | - | - |
| **TOTALS** | **23.2** | **6.3** | **27** | **6.7** | **29** | **7.0** | **30** | **0.5** | **2** | **2.8** | **12** | **6.7** | **29** | **10.3** | **44** | **5.4** | **23** | **0.5** | **2** | **0.4** | **2** |

Table 3.2. Bank erosion potential from surveyed reaches within the Lower Pajaro River study area.

Conversely, stream channels to the north in the upper Green Valley watershed consist of coarser sediment, large woody debris accumulations and less landsliding. This natural variability plays an important role in dictating the conditions of the stream channels and their impact on sediment transport, channel aggradation, bank stability and flooding in the lower reaches.

## 3.4. Assessment Summary by Subarea

The following summaries are presented by subarea. These were developed from observations or information provided during site visits and observations from public access points.

### 3.4.1. Casserly Creek Watershed

***Green Valley***

While many of the soils in the mountainous headwaters of the watershed have moderate to very high erosion risk, there are only small localized problems. The timber and rangelands assessed in the upper reaches largely are under a variety of 'best management' practices. Many of the tributary streams in the upper watershed area are in stable condition (Figure 3.5).

On the Estrada Ranch, roads on the ranch have been 'outsloped' to minimize the need for culverts and swales. Dips have been installed to improve road surface drainage. Most culverts have been replaced, are generally oversized, and all have been 'perched' to allow for sediment catchment basins on the uphill side which are cleaned on an annual basis. Recent log landing areas (within last 2 years) are reseeded heavily with pasture mix and many range areas are also reseeded with an oat,brome, ryegrass, and vetch mix to reduce thistle populations and improve forage quality. Residual dry matter following grazing is excellent and is also due to the relatively low number of animals. Water troughs, feed by spring or well, are numerous and located to discourage livestock from entering or lingering in creek channels. There was no evidence of significant bank instability or downcutting due to grazing in riparian zones where animals can access.

There are a number of older landslides and slumps, typically associated with intense storm events during past El Nino years. There are also a number of slides in areas along the upper reaches of the Green Valley channel adjacent to Hazel Dell Road. In some cases it is clear that the road alignment was constructed too close to the creek and are numerous recent slides that are endangering the road and resulting in mass wasting of sediment to the stream. A recent culvert replacement (between milepost 1.93 to 2.07) along Hazel Dell Road appears to be failing. The new drainage system does not effectively manage runoff from the road that is now causing the road and creek bank to be eroded. Increased runoff from the Summit and Mt. Madonna roads have increasingly led to failure of some older culverts and required installation of larger culverts to handle the increased runoff. It was also noted that the use of fill for road bank repair that is 'contaminated' with star thistle seed has caused localized stands of this noxious weed.

Figure 3.5. Tributary stream in upper watershed of Green Valley Creek

Site visits in the lower watershed area reveals bank instability and channel downcutting are significant issues affecting the use and value of properties in or adjacent to the riparian zones. It was generally observed that at many locations buildings or other land uses (including residential uses) have encroached and compromised the integrity of riparian zones. This was noted specifically in the area of Wheelock and Casserly Roads. This has clearly been a problem in this area of Green Valley Creek for many years. At least two restoration projects and recently installed bank protection using a gabion wall have been carried out by private landowners. Some of the erosion problems in the stream are attributed to removal and loss of riparian trees and placement of accessory structures too close to the streambank. Areas of bank instability were often noted on the upstream and downstream sides of County road overpasses. A landowner noted that since his purchase of his property in the mid-nineteen eighties, he has observed increased downcutting and sedimentation in the creek channel. What was once a well-sorted gravel bed are now largely fine sediments. This is likely aggravated by the presence of Baywood series soils along the riparian zone, which is a particularly erosion-prone soil type.

The new Suncrest Nursery site has undergone substantial renovation and many of the previous problems related to drainage and sedimentation from the previous nursery business have been mitigated. The nursery includes glasshouse and outdoor production areas where drainage waters are collected and piped to a pond. Overflow from the catchment pond is conveyed by a culvert and enters Green Valley Creek. Due to the rapid infiltration of the ponds, apparently, little of the runoff appears to be entering the creek. In three visits to the outlet during the winter of 2000/01, there was never any evidence of flow into the creek.

The majority of lower Green Valley Creek has good canopy cover with a cottonwood, willow, redwood and coast live oak overstory, and blackberry and poison oak understory (Figure 3.6). Native riparian species recruitment in these reaches probably occurs from native riparian plants in the largely intact upstream reaches. Non-native A*rundo donax* occurs in some portions of the streambank and top of bank where previous removal of native vegetation has occurred. There is good riparian canopy cover with bank slope cover vegetation approaching 85% in the lower reaches.

Though much of the riparian corridor within the lower Green Valley watershed is intact, the stream survey work suggest that many of the channels are experiencing high to very high erosion potentials. This is predominately due to the extensive downcutting that is occurring along Green Valley Creek with little room for the channel to adjust. Roads and property boundaries constrict lateral channel movement. Woody debris is also removed from the channels for flood control purposes when in fact this material may provide for sediment storage and reduce channel downcutting.

In summary, inadequate drainage systems from rural residential, horticultural, and other agricultural activities have increased runoff rates in the watershed. Minimal or no setbacks from the riparian corridors combined with loss or removal of riparian vegetation are accelerate downcutting and bank loss along the Green Valley Creek channel.

***Spring Hills Watershed***

The primary impacts to the channels within the Spring Hills watershed relates to past channel relocation and straightening to accommodate roads, golf cart paths and fairways. Many of the channels through the lower part of the watershed lack riparian vegetation and the banks consist of steep banks composed predominately of fine sediment resulting in extreme bank erosion potential.

This watershed above Casserly Road has little native riparian vegetation. In some areas, golf course turf provides some vegetative protection of the channel banks, but rooting depth is shallow in these areas. In other areas the turf appeared to be dead or was missing altogether leaving exposed dirt streambanks. In the stream reach just above Casserly Road, below the golf course, top of bank vegetation consisted of eucalyptus plantings and a flower farm with no side bank vegetation. Immediately downstream of Casserly Road, an almost continuous arroyo and yellow willow overstory and blackberry understory provide effective protection of the right streambank. Mature willows at the top of bank provide a good buffer from adjacent agricultural land uses. The left bank has a more discontinuous canopy cover of willow with dense Himalaya berry understory providing moderate bank protection. Further downstream, review of aerial photos showed a reduced riparian canopy and understory.

Figure 3.6. Lower Reach of Green Valley Creek

***Casserly***

The upper watershed areas are similar to that described for Green Valley watershed. The lower watershed portion of this subarea ends at Paulsen Road, prior to the creek's entry into College Lake. This portion of the creek has been channelized in the past and the riparian zone has segments that are poorly vegetated. In the upstream area visible from Paulsen Road it appears that cropland have encroached into the former riparian corridor and, in some cases, may directly discharge either tailwater or winter runoff into the stream.

Approximately 0.7 miles of channel was surveyed for bank stability and channel conditions. Based on limited field sampling, the results suggest high to extreme erosion potentials. Very little data exists on the mainstem downstream of the confluence with Green Valley Creek. The predominant processes that are contributing to the instability in Casserly Creek are channel downcutting and resulting bank steepening and failure.

Upstream of Casserly Grocery (Mt. Madonna Rd.) is a fairly diverse native riparian canopy consisting of willow, oak, maple and alder with scattered redwood and eucalyptus. Further upstream (approximately 1 mile up Mt. Madonna Road), mature riparian tree canopy changes to a predominant redwood and eucalyptus canopy with dense native and non-native understory. Understory vegetation covers about 40-65% on each streambank, but rooting depth is good at approximately 5 feet. The reach just below Casserly Grocery has a non-native eucalyptus overstory with non-native English ivy understory (Figure 3.7). Approximately 50-70% of both banks is vegetated, however the high density and shade from eucalyptus and ivy is preventing the establishment of native riparian species. Channel incision in this area may be at least partially due to non-native vegetation in this area and reduced bank vegetation downstream. Approximately 225 feet below Casserly store, the eucalyptus transitions into an oak, willow and California black walnut overstory, with a poison oak-poison hemlock understory. Vegetation coverage of both streambanks increased to 70-80%. The lower reaches of mainstem Casserly Creek traverse private property and were unable to be surveyed. In upstream sections of these reaches, a very narrow band of riparian vegetation is indicated from review of aerial photos. Downstream of the Green Valley/Spring Hills drainage confluence, the riparian canopy increases.

In summary, the minimal or no setbacks from the riparian corridor combined with loss and removal of riparian vegetation are contributing to additional channel downcutting, bank instability, and sedimentation in the area of Paulsen Road.

Figure 3.7. Casserly Creek

***Hughes***

None of the upper portion of the watershed was accessible for direct assessment and only a limited amount of upland areas were assessed.

Recent land use changes in the footslope area include conversion of pasture to berry production in 1995 and a recent conversion to flower bulb production. These production system share some common aspects, fall planting and largely bare winter fallow with compacted furrows to facilitate rapid runoff, that increase the total volume of water and sediment exported from these fields and directed into existing drainage system. There have been increased sediment loads during winter flows associated with these conversions. The fields have all been laid out to direct winter rain and irrigation runoff either directly to the creek or to a sediment basin. The sediment basin appears to have failed and sediment was observed in the culvert connecting this basin to the creek channel. While the soil type (Elder sandy loam) is typically not prone to erosion, poor water management is leading to substantial soil loss on these converted areas on slopes no greater than 9 percent. The increased flow is clearly contributing to increased instability of the banks of this creek adjacent to Suncrest.

Below this property the lower portion of Hughes and an unnamed tributary stream, that flows adjacent to another nursery property have been channelized and receive storm and tailwater runoff from adjacent fields. The unnamed creek, that at one time fed into Rose (Rowe's) Reservoir creek has lost a significant amount of riparian vegetation in some areas.

Many of the channels that occur on lower Hughes Creek have been straightened along property lines and are essentially managed as agricultural ditches. The result has been channel downcutting and loss of bank stability where riparian vegetation has been periodically removed.

Hughes Creek just above Casserly Road has a well-developed mature riparian canopy consisting of arroyo and yellow willow, black walnut, and maple providing almost complete canopy coverage of the stream. Stream banks are well protected by roots of mature riparian trees. Root structure extends 5+ feet from top to bottom of streambank. Although some poison hemlock is present on the upper streambank, this reach of creek has some of the best riparian vegetation in the lowland study area. Just below Casserly Road, the riparian canopy consists of sycamore, native black walnut and cottonwood with a Himalaya berry understory. Further downstream riparian canopy becomes scattered to non-existent as reviewed from air photos. Much of Hughes Creek below Casserly Road is located on private property not able to be surveyed from public access points. The two tributaries surveyed are sparsely vegetated with blackberry, willow and arundo. Rose reservoir has a mix of riparian and wetland vegetation with willow riparian cover in the tributary above the reservoir.

Although access to lands and riparian areas was limited in this subarea, it appears that increased runoff associated with agricultural activities, specifically berry and bulb production have increased runoff rates resulting in stream bank instability and erosion in this watershed. Minimal or no setbacks from the riparian corridor combined with loss or removal of riparian vegetation appear to exacerbate localized downcutting, bank failure, and sedimentation.

***College Lake***

College Lake serves as a large sediment catchment for Casserly Creek and an unnamed creek feeds into the eastern side of the lake. Substantial amount of sediment has been deposited at the north end of the lake where Casserly Creek crosses Paulsen Road. While the Santa Cruz County Soil Survey notes the soil type south of Paulsen Road to be Conejo loam, currently the surface is covered by coarse to fine sands and gravel sediment. Within the past two winters the channel of Casserly Creek at this location has shifted. Until recently, the stream channel was routed around the north and eastside of the lake to join with the channel entering on the eastern side. A levee had been constructed to maintain the course of the channel. Apparently, the former channel became dammed with debris and high runoff events in 1999 caused the old levee to breach. In the past the channel entered a broad vegetated swale, and a significant amount of sediment deposited in this reach of the stream upstream of the lake. Presently, the new course of the channel allows more sediment to be transported into and through the lake to the pump station at the lake outlet and into Corralitos-Salsipuedes Creek.

Approximately 3.6 miles of channel within the College Lake watershed was surveyed for bank stability and channel conditions. The bank and channel conditions within this watershed are influenced by the seasonal lake. The backwatering or changes in water levels in the lake results in highly unstable channels that are easily eroded and contributing to local sedimentation problems. Off-road vehicle use where Casserly Creek enters the lake is also resulting in poor channel stability and erosion in this part of the lake basin.

On the westerly tributaries, streambanks are vegetated with blackberry, poison oak, arundo and low-growing willow. The overhead canopy is sparse consisting primarily of willow, and some cottonwood. Vegetation coverage of bank slopes is about 50% with ½ to 1 ½ foot rooting depth upstream of Paulsen Rd., increasing to 65 to 70% coverage with 2 foot rooting depth downstream. The middle reaches above College Lake, north of Paulsen Road are largely devoid of bank vegetation other than non-native arundo, but have abundant emergent wetland vegetation (duckweed, cattail) due to slow-moving water. However, this emergent vegetation provides little erosion protection. Willow thickets and some oak are present on streambanks downstream of Paulsen Rd. Bank vegetation coverage on these reaches ranges from 0 to about 40%. Further east, a tributary that lies adjacent to Paulsen Rd, then flows south adjacent to an arm of College Lake has a relative intact willow-cottonwood riparian community. The major branch of Casserly Creek flowing into College Lake has good willow riparian bank vegetation above the Paulsen Rd. dead-end berm with scattered immature willow and non-native herbaceous vegetation below. The absence of mature riparian vegetation and defined channel banks on the stream reach below Paulsen, coupled with evidence of significant sediment deposition, and presence of dry riparian channels to the east, indicate that the stream channel may be meandering across the upper College Lake flood plain in this location. A 4-wheel drive truck was observed driving up and down the stream near the Paulsen dead-end berm.

Stream reaches below College Lake are farm ditches largely devoid of vegetation, or intermittently covered with low-growing, non-native ruderal vegetation. No native riparian species were noted in these reaches. Further downstream near Highway 152, Holohan Road and the confluence of Salsipuedes Creek, the canopy cover increases with scattered mature willow, cottonwood, maple and California black walnut along both banks. Near Holohan-College roads. the left bank has good riparian canopy coverage with sparse coverage on the right bank. Native riparian trees protect approximately 45% of both bank slopes.

***College Lake East***

The headwater of the unnamed seasonal creek that ultimately flows into the eastside of College Lake originates in the upper watershed area of the D&D Ranch. This upper reach flows through a mixture of oak and scrub woodland and rangeland prior to it crossing under Highway 152. Livestock have little access to this channel and, in general, the location of numerous water troughs and supplemental feeding stations, along with many areas with shade trees discourage livestock use of the riparian zone. While the upper reach is near a number of graded ranch roads, there are no direct discharges to or crossings of this channel by roads. In recent years, some roads have been relocated or regraded to reduce erosion from road cuts. Some of the roads have been outsloped, and where practical road dips are being employed. While there are some roads constructed on significant slopes that appear more susceptible to erosion, these areas are remote from any seasonal drainage or the creek, and these are not sediment sources to surface water. In the El Nino winter of 1995 there was significant bank and vegetation loss on the lower portion of this creek before it flows under Highway 152. This portion of the creek receives additional runoff from Highway 152, that enters the channel at high velocity, resulting in scour that continues to have impacts on the channel immediately downstream. There is no impact on this portion of the creek from grazing.

Bank instability appears to increase as the creek flows under Highway 152. Here the banks are non-vegetated and have been randomly armored with concrete and rock. Berry production and field access roads are immediately adjacent to the channel.

The lower reaches of the College Lake East watershed is experiencing heavy sedimentation resulting in extensive aggradation and loss of overall channel stability. Approximately 82% of the 0.8 miles of channel that was surveyed were rated to have very high to extreme erosion potential.

The reaches between Highway 152 and Casserly Road have very little vegetation due to concrete armoring of channel bottom and banks. A native riparian canopy is absent and bank vegetation protects 2% to 8% of the streambanks surveyed. Just upstream of Casserly Road, the bank slopes are bare except for scattered mature California black walnut at the top of bank. Downstream of Casserly Road scattered immature black walnut, maple and non-native grasses are protruding through the concrete armoring. The downstream reach adjacent to the fairgrounds has a poorly defined channel with some willow, blackberry and maple on the channel bottom and non-native weeds and thistles on the bank slopes and top of bank.

### 3.4.2. Kelly Lake Watershed

The upper portion of the Kelly Lake drainage originates on the D&D Ranch as a series of drainage ditches on the row crop fields on the northeast side of Carlton Road and southeast of Highway 152. D& D Ranch lease the fields. The ditches convey runoff from the lower portions of the rangelands and the row crop blocks (bushberry and vegetable rotation) into a culvert on Carlton Road. In general, the ditch system on the D&D Ranch are well maintained and are vegetated in some sections. During the winter of 2000, the only sources of sediment-laden runoff came from small plastic-lined ditches that were installed by the tenant to convey water from the lower portions of fallowed fields directly into the road ditch along Carlton Road. Better installation of such ditches would minimize soil loss.

Only approximately 0.6 miles of the channels were surveyed for bank stability. In the areas that were surveyed the results show very high erosion potential due to channel incision and oversteepening of the banks.

The extent of riparian vegetation was largely unsurveyed due to lack of public access points. The surveyed reach at Carlton Road was a farm ditch with no riparian canopy and approximately 30% plant coverage of streambanks with non-native weedy species. Aerial photo review indicated similar conditions in other upstream reaches, with some more extensive herbaceous vegetation and small willows on streambanks immediately upstream of the lake.

### 3.4.3. Pinto Lake

Approximately 0.5 miles of the Pinto Lake watershed was surveyed in this assessment providing a limited assessment of the entire watershed area. The field assessment suggests that this watershed is in moderate condition. The stream channels surveyed are experiencing some downcutting and bank failure attributed to a loss of riparian vegetation.

The lower reach of the west tributary to Pinto Lake contains a willow, alder, buckeye tree canopy with a poison oak and blackberry understory. Canopy cover is approximately 45%, with a 3 foot rooting depth on 60% of surveyed bank slopes. Above Pioneer Road, the canopy and bank cover are reduced with eucalyptus and willow the predominant species. Approximately ¼ of the bank slope is vegetated with a rooting depth of ½ foot.

3.4.4. Tynan Creek Watershed

The upper watershed area of the Tynan Creek subarea begins on the lower portions of the D&D Ranch. Recent conversion to cane- and strawberry production of lands immediately below the origins of one of the unnamed creeks (Peckham Road) has lead to significant increases in sediment loads. A sediment pond installed on the northwestern side of lower Peckham Road appears to be inadequate. The creek has been channelized and has almost no intact riparian vegetation along its entire reach. The channel has been moved in many places to flow along the many property boundaries in the area from Peckham to Coward roads. This includes severe bends (45 to 90 degrees) that along with the lack of permanent vegetation results in high bank instability, erosion, and sedimentation.

In the upper reach, there is a small slowly eroding slump along a short (150 foot) stretch of this drainage. The slump appears to be resulting from a loss of trees and shrub vegetation several years ago, and the subsurface soils are erosion-prone Diablo clay and Aptos loam soils. Presently, much of this slump is vegetated with grasses and appears relatively stable. Only a small area of bare bank is exposed.

Erosion of the channel appears to increase as the creek channel moves through berry fields where there is no riparian vegetation or setback from cropping. The landowners noted that there has been an increased volume of runoff entering the sediment basin, which typically fills early in the season and routine overtops or releases sediment to Peckham Road during the rainy season. Bank armoring, with concrete and riprap, has been installed on portions of the channel on the reach below Carlton Road.

Below this reach, another landowner has noted that increase runoff and sediment enter the system from another seasonal channel. Channel clearing of ditches on private lands above Coward Road also appears to be contributing to some of the sediment deposited in the ditch system that ultimately flows to the Martin Creek drainage downstream of Tynan Lake.

Channel modification and removal or loss of riparian vegetation is increasing erosion and sedimentation in the channel that originates at the D&D Ranch, runs along Lakeview Road, and ultimately drains into Tynan Lake. It was noted that many small fields in the upper portion of Lakeview Road have beds oriented downslope, which accelerates runoff and soil loss from these fields. At least two older road culverts (that are likely undersized) tend to become clogged with sediment due to erosion of soil from fields above Tynan Lake.

The fields around lower Tynan Lake all have non-vegetated buffers of about 40 to 50 feet, yet there is still evidence of some sheet runoff into the Lake. Below Tynan Lake a series of agricultural ditches feed into the channelized Martin Creek. Martin Creek flows under Highway 129 and into the Pajaro River. The channel is filled with fine sediment and annually the vegetation is cleared from the channel banks, leaving bare sloping banks.

The upper reach surveyed near Carlton Road has mature willows and a blackberry understory but no defined channel bottom. The lower reaches above the Lake are largely devoid of vegetation with no riparian canopy. 5 to 12 % of the bank slopes are covered with grass and non-native (weedy) herbaceous vegetation.

The easterly Tynan tributaries (also known as Martin Creek) are largely agricultural field ditches with grass or non-native weedy vegetation on the banks. Overhanging native riparian vegetation is absent (Figures 3.8. and 3.9). Bank coverage with herbaceous vegetation varies from 0 to 30%, with most bank coverage in the 8-10% range. Below Tynan Lake, the channel border agricultural fields and is entirely devoid of bank or riparian overstory vegetation.

The biggest issue facing the Tynan-Martin Creek watershed is aggradation of the channels from excessive sediment loads. There are several areas were the channels have been completely buried by fine sediment, resulting in clogged culverts and ponded water during the winter season. Of the approximately 4 miles of channels surveyed, 75% are rated as having a very high to extreme erosion potential. Loss of permanent riparian vegetation, annual removal of herbaceous vegetation just prior to the rainy season, channel modification, and minimal to no setbacks of buffers are resulting in substantial erosion and sedimentation in the entire Tynan subarea.

Figure 3.8. Tynan/Martin Creek downstream of Tynan Lake

Figure 3.9. Tynan/Martin Creek Upstream of Highway 129

3.4.5. Coward Creek Watershed

The Coward Creek watershed is experiencing the most significant erosion and sedimentation problems in the study area. In the winter of 1998 a portion of Carlton Road was undercut and a large area of creek bank was lost. The Santa Cruz County Public Works Department Drainage Division (County Drainage Division) reported that removing sediment from lower Coward Creek, downstream of Highway 129, over the past several years, have been the largest maintenance projects completed by Department. El Nino events in 1998 that led to the loss of a portion of Carlton Road is believed to have been due to a landslide and subsequent debris flow that occurred in the upper watershed of Coward Creek. The slide was located during the assessment and the scar on the western slope above the channel is still visible.

The upper watershed reaches of Coward Creek originate on the Kelly-Thompson Ranch (Figure 3.10). While the upper portion of the ranch is mostly rangeland, dense riparian vegetation is largely intact in the four main branches of the upper Coward watershed (Figure 3.11). This includes Arano, Cummings, Kinky, and Mill Creek canyons. The main channel alignment is along the San Andreas Fault line, and unlike the other upland areas assessed, the influence of the fault is more apparent. The low gradient valley that has formed above the upper Coward Creek channel functions as a partial sediment trap for Mills and Kinky Creeks. However, on the northern portions of the upper watershed, there are many unstable areas as evidenced by slips, slumps, and small gullies. On the eastern slopes above the channel are some of the more erodible soil types in the study area, Diablo clay and Fagan loam, which have restricted infiltration and a high shrink-swell clay mineralogy. These soil and slope factors, including the proximity to the fault zone, are the major causes for slides and mass wasting of sediments in the watershed. The intensive grazing practices on the property are not resulting in erosion and sedimentation problems. The rangelands are currently leased to a rancher who does not import feed and relies heavily on rotational grazing (with electric fencing) and utilization of all forage. At the time of the site visit (in early May 2001), there was little indication of overgrazing. The western slopes above the channel (Porter Ranch) are heavily forested but very steep (up to 70 percent) and are the highly erodible Lompico-Felton soil series.

At a point above the upper portion of Peckham Road, Arano Creek, which originates on the a private ranch, flows into the Coward channel. A graded road crossing here is seldom used, but has required attention during and following heavy winter rainfall seasons.

The characteristics of the upper watershed result in a large amount of natural sediment production. As the creek reaches the valley floor and moves towards lower Carlton Road and Highway 129 this sediment is deposited in the channel, which results in channel aggradation (filling). Maintenance of the channel is necessary to maintain the viability and value of the agricultural lands adjacent to the creek. This reach of Coward Creek has no riparian vegetation and agricultural setbacks are minimal. Landowners, leasees, and/or the County Drainage Division sporadically clear the channel. Intermittent clearing and unstable banks lead to chronic and acute erosion problems in this area.

Figure 3.10. Upper Coward Creek Watershed

Figure 3.11. Upper Coward Creek

Approximately 3.1 miles of channel in the Coward Creek watershed were surveyed with a majority of the channels having a high to very high erosion potential.

Localized flooding in the area of Thompson and Carlton Roads, as well as substantially flooding due to breaches of the Coward Creek levee below Highway 129 were reoccurring events during the wetter than average period in the later 1990's. Jim Rider's home ranch is largely on the nearly level valley floor. In 1998, the company office and processing buildings were flooded when Coward Creek overtopped its banks. This occurred during the same storm event that led to the undercutting and loss of a substantial length of Carlton Road upstream (Figure 3.12). Debris from the bank failure clogged the Coward Creek culvert near the intersection of Thompson and Carlton Road causing the creek to overtop the channel. Mr. Rider noted that there has been no consistent or coordinated maintenance/renovation of the Coward Creek channel in this area. Due to topography and continued sedimentation in the lower stretch of the creek, the bottom of the channel is actually higher than much of his property. There is a long stretch (about 800 feet) of the channel south of Carlton Road that is sporadically dredged out by the grower leasing the adjacent parcel. Typically sediment is simply piled up along the bank of channel and eventually erodes back into the creek in the winter.

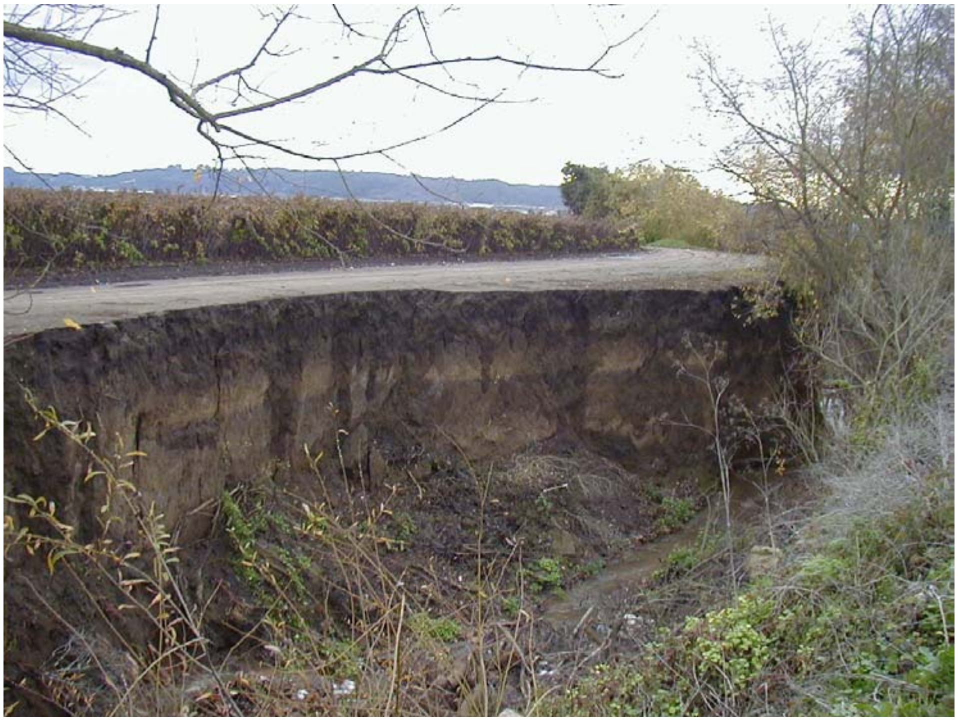


Figure 3.12. Bank Failure on Coward Creek along Carlton Road

In reaches were vegetation is well established, the banks are typically more stable, as can be seen immediately downstream of the large bank failure on Coward Creek (Figure 3.13).

Figure 3.13. Coward Creek Downstream of Carlton Road

Below Highway 129 the County Drainage Division attempts to clean out the ditches annually (Figure 3.14). However, due to budget and resource constraints much of this work does not always get completed each year. In addition, no comprehensive drainage studies have been completed for this area to determine what improvement or maintenance work is required to improve and/or maintain effective drainage in the area. Many of the growers in the area are concerned that the maintenance worked conducted by the County is not affective and not addressing long-term drainage problems in the areas. Most of the concern is related to the continued filling of the channel.

Upper Coward Creek, above the north Carlton-Thompson Rd. intersection, has an oak-eucalyptus canopy with approximately 75% bank coverage. Understory vegetation is predominately non-native German ivy. Root density and bank coverage varies from 65 to 75% on the right and left banks respectively. Rooting depths are about 2 feet on a 12' high bank. South of this intersection, Coward Creek crosses a farm field to a point just west of a second Carlton-Thompson intersection, and is largely devoid of any vegetation. Vegetation downstream has also been removed to a point several hundred feet upstream of Highway 129 where approximately 35 to 40 % of the bank is covered with non-native ruderal herbaceous species such as thistle, mustard and tobacco. These species have a rooting depth of ½ foot and provide minimal bank protection. Downstream of Highway 129, weedy herbaceous vegetation covers 5 to 20% of the streambanks, with some immature willows in the channel bottom. Further downstream, just above the Pajaro River confluence, ruderal bank vegetation varies from 0 to 25%, again providing minimal protection from erosion.

Large sediment flows from the upper watershed are mostly uncontrollable. However, loss and removal of riparian vegetation, past channelization, and poorly coordinated maintenance of the lower channel continue to result in excessive bank instability, erosion, localized flooding, and sedimentation.

Figure 3.14. Lower Coward Creek downstream of Highway 129

3.4.6. Thompson Creek Watershed

Changes in land use, obsolete drainage infrastructure, poorly coordinated maintenance of roadway ditches, and large uncontrollable sources of sediment contribute to a complex problem in this area. A number of unnamed seasonal creeks on Kelly-Thompson and Porter Ranches form the origins of this drainage area. Flows from field and roadway drainage ditches along Thompson and Carlton Roads ultimately form a confluence on the lower portion of Kelly-Thompson Ranch above Highway 129. During significant winter storm events a very large volume of water flows through a sediment pond above 129 to a now undersized culvert under the highway.

Above Thompson Road an old grassed ditch conveys water from the lower portion of the Porter Ranch towards a culvert running under Thompson Road. Between this ditch and the road are fields that in the past 10 years have been converted from apples to vegetable and berry row crops. In the winter these fields (dependent on crop rotation) can generate large volumes of runoff that is discharged into the aforementioned ditch or into the road ditch along Thompson Road. This has led to erosion of the south shoulder of the road, and alternately down cutting and sedimentation of the ditch as it flows into the upper Thompson Road culvert. Flow out of the culvert is also eroding the ditch and conveys this sediment into another ditch system that leads to the Kelly-Thompson Ranch. Poor winter runoff management in recent years is both undermining the road and exposing buried irrigation piping in this area (Figure 3.15).

Figure 3.15. Drainage ditch along Thompson Road

Just below the 90-degree turn on upper Thompson Road, winter runoff and irrigation tailwater is discharged from all of the fields to the northwestern side of the road. Runoff enters a poorly defined and maintained roadway ditch. This system routinely fails each winter releasing a substantial amount of sediment on Thompson Road or into the road ditches and conveyed down the ditches to an old and now undersized culvert. Runoff from this area is drained to an open channel ditch that runs along Carlton Road. Conversion of orchards on the northwest side of Thompson Road to strawberry and vegetable row cropping has dramatically increased the volume and velocity of runoff and increased erosion of tailwater ditches conveying this water to Thompson Road (Figure 3.16). Annually, landowners in the area must remove sediment from the road, driveways, parking area, and, in some years, the inside of buildings. Portions of the road ditch have been removed and paved for driveways and there has been no coordinated maintenance of this ditch in years. Long time owners of property in this area have no memories of this ditch being maintained.


Figure 3.16. Road damage from drainage along Thompson Road

At the intersection of Thompson and Carlton Roads, the culvert often becomes clogged with debris and sediment, or simply too much water arriving at the inlet. When this occurs, the intersection and the Rider home ranch property are flooded with water and sediment. The ditch along Carlton Road is also poorly maintained (with the exception of the lower portion where it is cleaned annually by the Kelly-Thompson Ranch personnel or contractors). Perhaps a 300 to 400 foot stretch of the ditch has been filled with sediment and has been non-functional for at least three winter seasons. As a result, runoff and sediment are deposited on the road and in large storm events the road is submerged under 1 to 3 inches of water for up to 48 hours after such events. Mr. Scurich and Mr. Rider have had to install their drainage measures to redirect water and sediment from entering their properties.

Mr. Scurich has installed a concrete barrier around his cooler to prevent sediment and water from entering his site and building. His property along Carlton Road is being undermined by erosion of the road ditch due to the high runoff rates from the Thompson Road (Figure 3.17). When the culvert is clogged and overloaded, runoff and debris enters Mr. Rider's property. To mitigate these impacts and protect his property and fields, in 1995 Mr. Rider installed a large ditch and berm along the northeast side of Carlton Road.

Figure 3.17. Drainage Ditch at Thompson and Carlton Roads

The system of ditches and culverts draining the Thompson and Carlton Road areas is undersized and in poor condition and routinely overloaded with water and sediment (Figure 3.18). This is particularly problematic when the land above Carlton Road is planted in berries. In the past two seasons temporary plastic Quonset-type shelters were used to enhance bush berry production. When late or early rainy season events occur, peak runoff rates and volume increase substantially from these impervious areas and overwhelms the existing drainage systems.

The lower portion of the Kelly-Thompson Ranch has two main channels that convey water originating on the lower portion of the rangelands on the ranch and the drainage from the lower portion of the Porter Ranch. The steep canyons in the upper watershed (largely Aptos and Los Osos loam soils) that convey high flows that transport large amounts of sediment that tends to be deposited in the lower channel reaches. In the mid-1980's conversion of a portion of the ranch from apples to row crop resulted in the relocation of the natural creek channel. Prior to this, the sediments transported from the uplands were deposited in the channel and floodplain of this creek with no harm to the orchards. In order to have viable row cropping, the relocation of this channel required construction of a large ditch and the construction of a sediment pond near Highway 129 (Figures 19 and 20). Sedimentation of these channels is a chronic problem and every year approximately 10,000 cubic yards of sediment is removed to maintain channel capacity (Fred Silva, personal communication). Currently, drainage systems from this ranch, the lower Porter Ranch, and the Thompson Road area enter a small sediment pond constructed by the Kelly-Thompson Ranch as a interim measure to control runoff and capture sediment to minimize flooding problems at Highway 129. Two culverts under Highway 129 drain this pond.

Figure 3.18. Drainage ditch along Carlton Road

The culverts under Highway 129 (milepost 3.53) are undersized for the volume of water arriving to the sediment pond. The inlets and outlets of the culverts are prone to clogging. Typically, during largest winter storms the culverts are overwhelmed with debris, surcharged and water overtops the banks of the pond onto the highway. The runoff and suspended sediment that is transported through the culvert is typically deposited immediately downstream of the culvert, which reduces the flow capacity of the culvert during the winter. Drainage below the culvert is in a poorly defined channel that runs and drains into Pajaro River Figure 3.21). However, in the past this reach downstream of Highway 129 was a well-defined meandering channel.

Approximately 1.1 miles of the Thompson Creek watershed were surveyed with all channels being classified as having high erosion potential.

The series of drainage's that follow farm roads and the edges of farm fields on the valley floor lack riparian canopy or bank understory vegetation except for occasional ruderal (weedy) grasses and herbaceous species.

The key problems in this area are largely due to an obsolete drainage infrastructure that has failed to be improved as land use and production practices have changed. Increased runoff volumes from the Thompson Road area are causing localized flooding and sedimentation and is increasing the risk of vehicular accidents on Thompson and Carlton Roads. Ultimately much of this runoff and sediment flows through a small sediment pond (that likely fails early in the winter season) and an undersized and poorly positioned culvert. Aggradation of land on the south side of Highway 129 has furthered compromised the function of the sediment pond and culvert.

Figure 3.19. Kelly-Thompson Creek

3.4.7. Highway 129

This area represents a relatively small drainage that is separated from Tynan, Coward, and Thompson Creeks. This drainage begins above Highway 129 along the south side of Carlton Road, where a ditch and berm, maintained by Jim Rider conveys excess runoff from upper Thompson Road, southwest to a culvert under Highway 129 (milepost 3.15). In the late fall of 2000, this culvert was found to be completely clogged by soil and weeds that apparently accumulated over the past three winter seasons. When this drainage system is maintained, runoff enters the culvert under Highway 129 and a channel that used to run south to the Pajaro River. However, this channel is currently not maintained and the channel and direction of flow is not well defined. A second ditch parallel to Highway 129 currently receives runoff from the highway and this ditch has no outlet and appears to be maintained by growers to prevent runoff from Highway 129 from reaching fields along the south side of the highway.

Figure 3.20. Kelly-Thompson Sedimentation Pond/Culvert at Highway 129

Figure 3.21. Kelly-Thompson ditch downstream of Highway 129

Given the nearly continuous cropping of flowers (or historically apples) in the fields along Carlton Road, there is usually a vegetative cover. Runoff or sediment from these fields is minimal. However, during or following large storm events sediment laden runoff from upper Thompson Road can enter the drainage ditches surrounding these fields causing bank erosion or deposit sediment into or downstream of the ditches below Highway 129. During the winter of 2000, CalTrans reopened the Highway 129 culvert and a significant amount of sediment was transported downstream of the highway. The lower portion of the old channel that still drains into the Pajaro River receives tailwater and winter runoff from the adjacent row crop fields. It is not vegetated and there is evidence of sediment transport past the flap gate in the levee wall.

The integrity of this drainage has been degraded as multiple lease tenants have used the adjacent fields for a variety of crops. It appears that at one time the ditch parallel to the south side of Highway 129 (running from Coward Creek east to the intersection of Carlton Rd.) fed the channel that discharges to the Pajaro River. There does not appear to be any coordinated or routine management and/or maintenance of this drainage system.

# 4. Summary of Findings

## 4.1. Physical Conditions

11. In general land use in the upper watershed areas of all the sub-areas have been under similar uses and management for the past century and few problem areas are present. In general there is little access to seasonal creeks by livestock although there are very few areas with riparian fencing.
12. Several factors throughout the study area, including conversion of agricultural lands over the past two decades to production systems that require rapid drainage (Sic. runoff) during the winter and rural residential development has overwhelmed aged and undersized drainage infrastructure. This infrastructure includes roadway ditches, agricultural ditches, culverts and channelized creeks. These factors are resulting in increased problems with localized flooding and sedimentation, loss of agricultural soils, collapse of roads, failure of drainage ditches, increased instability of creek channels and loss of riparian vegetation.
13. Minimal or no setbacks from the waterways combined with loss or removal of riparian vegetation appear to be significant contributors to downcutting and bank failure resulting in significant loss of private land and public roads.
14. Several streams and waterways have been channelized with severe bends (45 to 90 degrees) that, along with the lack of permanent vegetation, result in high bank instability, erosion, and sedimentation.
15. A substantial percentage of lowland streams in the study area have little or no native riparian vegetation due to plant removal by herbicide or mechanical means, or channel relocation to the edges of properties.
16. Stream reaches with a mature riparian vegetation canopy (trees) and a relatively complete native or non-native understory generally have relatively intact streambanks, although stream downcutting still occurs due to unstable conditions up or downstream.
17. Loss of permanent riparian vegetation, annual removal of herbaceous vegetation just prior to the rainy season, channel modifications, and minimal to no buffers are resulting in large annual sediment loads from private and publicly managed lands.
18. Where riparian vegetation is absent or where native species have been overtaken by shallow-rooting non-native weedy species, there is little protection against bank slope failure and significant erosion.
19. Stream reaches in the study area experiencing minor bank erosion are often reaches that are aggrading or banks are relatively low, well vegetated and/or mildly angled side slopes, such as Salsipuedes or Spring Hills streams.
20. Other streams, such as Green Valley and Casserly, have intact riparian corridors, but some reaches are experiencing downcutting and severe bank instability. This condition result in a high potential for erosion and loss of established riparian vegetation as the banks become undermined. This may be attributed to several factors including the increased runoff from recently developed land, lowering of the shallow groundwater, and channelization.

### 4.2. Management Issues

11. There are a limited number of landowners who have adopted best management practices to control runoff, erosion and sediment on their lands. These projects are successfully reducing sedimentation in the project area.
12. Several of the landowners that participated in the assessment phase of the project are very interested in developing long-term solutions to address drainage and erosion problems throughout the watershed. Many landowners are even willing to provide financial assistance to remedy drainage and bank stabilization problems affecting their lands.
13. Multiple lease tenants are a common occurrence in the project area, and the responsibility for the coordinated management of the drainage system(s) serving a particular property can 'fall through the cracks' and result in accumulation of sediment in drainage ditches. During subsequent storm events, the ditches can over top causing localized flooding, erosion of roadways and release of sediment across roads and onto adjacent properties.
14. Increased tenant farming creates pressure to maximize economic return for both the landowner and leasee. In many areas this has pushed growers to farm close to the edge of the fields, minimizing setbacks from drainage courses. Double and triple cropping, along with berry production practices leave many fields bare during the winter months. These practices are contributing to erosion and sedimentation problems in downstream waterways.
15. Many of the waterways in the project area are significantly degraded and in many locations banks and channels are covered with debris. Tenants operating lands adjacent to these waterways may not recognize the function or importance of these waterways. Often, the short-term agricultural leases do not provide incentives to the growers to enhance or clean up the waterway and in some instances the waterways can become clandestine dumps.
16. There is lack of coordinated maintenance or enhancement efforts between owner/managers and County or State departments. There is a need to develop long-term coordinated private and public agency partnerships to carryout conservation projects in each watershed area.
17. Increased workload, and budget and staffing constraints, in the County's Drainage and Road Maintenance Departments, has limited these departments ability to maintain drainage infrastructure in the project area. Over the past several years the Road Maintenance Department has only been capable of undertaking emergency repairs and preventive maintenance activities have been delayed by approximately 2 to 3 years.
18. Substantial permitting requirements combined with limited staff resources imposes a lengthy, cumbersome and expensive process to undertake drainage and stream improvement projects by both private and public parties. This condition has created a severe disincentive for private landowners to undertake voluntary improvement projects. Currently, permitting for drainage and stream improvement projects can take over two years to be completed.
19. Practices and/or structures adopted by one owner/manager, have led to or have compounded 'downstream' problems for another owner/manager.
20. There is a perception that vegetated banks restrict stream flow and cause flooding. However, major flooding problems in the lowlands are not the result of vegetation but rather channels filling with sediment that could be kept on upstream property by using vegetation on stream banks and riparian buffers.

# 5. Overview

Several factors throughout the study area are contributing to severe erosion and sedimentation problems in the Pajaro Valley. Land conversion to more intensive crops, and rural residential development have increased the rate and volume of runoff entering aged and undersized drainage systems. Substantial stream and waterway hydromodifications (channelization and vegetation removal) have occurred that are causing severe bank erosion in many manmade and natural waterways. These factors are resulting in increased problems with localized flooding and sedimentation, loss of agricultural soils, collapse of roads, failure of drainage ditches, increased instability of creek channels and loss of riparian vegetation.

Part II presents an enhancement plan to outline actions that may be taken to address erosion and sedimentation issues in the lower Pajaro Valley, as well as projects that can restore and enhance riparian and wetland resources in the area.

A variety of on-farm best management practices (BMPs) can be used to control runoff, reduce erosion and the transport of sediment off of croplands. Similarly, biotechnical bank stabilization practices can be put in place to protect, repair and restore stream and waterway banks. Section Six of the enhancement plan describes on-farm BMPs and biotechnical stream bank stabilization techniques that have been used throughout the Monterey Bay region. Cost and performance data is also provided, where information was available.

Section Seven presents a series of stream bank stabilization and wetland enhancement demonstration projects. The demonstration projects describe the site conditions, present conceptual restoration plans, a analysis of engineering design and permitting requirements, outlines the pre- and post project monitoring and maintenance requirements and cost estimates for the implementation of the project.

Technical, managerial and financial issues have limited routine maintenance, planning and enhancement projects in the study area. In general, there is a lack of coordinated maintenance or enhancement efforts between owner/managers and County or State Agencies. Some deferred maintenance activities are not occurring, exacerbating erosion and sedimentation problems. There is a need to develop long-term coordinated private and public agency partnerships to carryout drainage improvement and conservation projects in each watershed area. Substantial permitting requirements combined with limited staff resources impose a lengthy, cumbersome and expensive process to undertake drainage and stream improvement projects by both private and public parties. This condition has created a severe disincentive for private landowners to undertake voluntary improvement projects. Currently, permitting for drainage and stream improvement projects can take over two years to be completed. Section Eight describes management, planning and implementation issues and actions recommended to improve these activities in the study area.

Section Nine identifies activities that should be undertaken to implement the enhancement plan. Preliminary budgets and timelines are presented to assist the SCCRCD and other agencies in the planning and implementation of the proposed activities.

# 6. BEST MANAGEMENT PRACTICES FOR ENHANCEMENT OPPORTUNITIES

## 6.1. Introduction

This section describes a variety of alternative on-farm and bank stabilization best management practices (BMP) that can be used to stabilize sediment (source control) and to reduce erosion and the delivery of sediment from upland areas and waterways. The practices described are well established techniques that are recommended by local, state and federal resource conservation agencies, including the Santa Cruz County Resource Conservation District and the Natural Resource Conservation Service.

All of the practices described are cost-effective methods that are designed to stabilize soil by primarily slowing runoff from the fields and by stabilizing stream and waterway banks that are experiencing excessive bank erosion. These two conditions are resulting in the most severe erosion and sedimentation problems in the Pajaro Valley region. Several of the recommended BMPs also provide additional benefits to the land by conserving soil, improving water infiltration and groundwater recharge, improving soil fertility, reducing costs for ongoing maintenance of infrastructure (access roads and drainage systems), reducing land loss, enhancing habitat and improving water quality.

Although, this section describes the different practices separately, many of the practices may be used in combination. For example, sedimentation basins are recommended widely throughout the Monterey Bay region as a preferred method to capture sediment from croplands. However, if sedimentation basins are used as the sole BMP, they may occupy a relatively large area. Using a combination of BMPs as a "pre-treatment" system, such as cover crops, vegetated roadways, grass-lined channels, velocity dissipaters, filter strips, or other techniques, the total sediment load delivered to a sediment basin would be reduced. Therefore a smaller sediment basin could be designed to better accommodate the site and cropping system.

### 6.1.1. <u>BMP Goals</u>

The overall goals of the best management practices include:

- The control of runoff;
- To reduce erosion and the transport of sediment off of croplands; and
- To repair and restore stream and waterway banks to stable conditions utilizing biotechnical methods

### 6.1.2. <u>Factors that Influence Erosion and Control Practices</u>

The principal factors that influence erosion and controls practices, include:

- Rainfall and climate conditions;
- Soil permeability;
- Runoff flow path and slope;
- Land cover; and
- Conservation practices.

**Rainfall/Climate.** A key factor on the success of any erosion and runoff control practice is the timing of implementation. The practice needs to be in place prior to the rainy season. This would apply to any practice that relies on soil stabilization, such as cover cropping, vegetated roadways, grassed waterways and/or other practices. In the Pajaro Valley most practices should be in place by mid October to be effective for early rainfall events that are common in early November.

**Soil Permeability**. Soil erodibility is primary a function of the soil texture and structure, the amount of organic matter and permeability of the soil. A soil that is more permeability with a high water holding capacity is generally less prone to erosion. Conversely a compacted soil can shed water off rapidly and the high velocity runoff will cause sheet and rill erosion on slopes. Incorporating organic matter into the soil can increase permeability and in most instances the fertility of the soil reducing erosion and improving crop yields.

**Flow Path Length and Slope.** Long drainage ditches on slopes can concentrate increase the velocity of runoff resulting in excessive erosion due to gullying and down stream impacts to road ditches or channels. Slowing water down by installing waterbars/dip, grass lined ditches and/or small checks can slow runoff down or redirect runoff to a stable discharge point before the volume and flow rate are excessive. These measures will reduce potential erosion.

**Cover.** Planting a cover on fields, roadways and other critical areas will reduce rainfall impact on soil, reduce surface water velocities and enhance infiltration. Vegetative covers, such as filter strips will filter sediment in surface runoff, retain soil particles in place and reinforce soil structure. The use of cover crops or other vegetation particularly along waterways can help to promote permanent vegetation establishment

**Conservation Practices.** Conservation practices are controllable, imaginative, experience-driven, and interactive factors that can enhance the factors of cover and soil texture, mitigate the influence of rainfall and runoff, and reduce runoff velocity – flow path length.

### 6.1.3. Why Use BMPs?

In the Pajaro Valley, climatic, topographic and geological forces contribute to natural erosion and sedimentation processes in the local streams and the Pajaro River. However, erosion problems are accelerated by a variety of human activities. Uncontrolled erosion is costly; exposes landowners to legal liabilities; impairs water quality and water conveyance capacity in waterways; and can potentially violate local, state and federal water pollution laws.

**Economic Advantages**

Adopting runoff, erosion and sediment control measures can provide numerous economic benefits to a landowner, neighborhood, and local and state agencies. Some of the benefits include:

- Stabilized sites require less repair and are safer for field workers;
- Reducing short- and long-term erosion will result in less soil loss;
- Reducing land loss due to streambank and ditch erosion;
- Reducing flooding hazards;
- Reducing removal of silt deposit from drainage ditches and sedimentation ponds;

- Negative public opinion, which can result in enforcement actions, can be minimized; and
- Liability exposure can be decreased

**Environmental Advantages**

Similarly, adopting BMPs can provide several environmental benefits, including:

- Reduction of toxic materials that are introduced into waterways by their attachment and transport by sediment particles
- Protection of aquatic life in streams and waterways
- Protection of human and well as wildlife uses of receiving waters

### 6.1.4. Erosion, Sediment and Runoff Controls

In planning, implementing and maintaining a runoff, erosion and sediment control BMP, it is important to understand the difference between the BMPs.

**Runoff Control.** Important to control concentrated flow with measures to prevent gullying and scour. Runoff controls are designed to control peak volume and flow rate by slowing water down and de-synchronize release to waterways.

**Erosion Control.** Erosion Control is any practice that protects the soil surface and prevents soils from being dislodged by rainfall and wind. Erosion control BMPs are source control practices that treats the soil as a resource that has value and should be kept in place. Generally speaking, erosion controls are more effective than sediment controls and should be the primary protection at the site, with sediment controls uses as a secondary control.

**Sediment Control.** Sediment Control is any practice that traps the sediment after they have been detached and moved by rainfall or wind. Sediment controls usually rely on a passive system for filtering or settling. Typically, soil collected is a sediment trap is considered debris and as a waste product that must be removed from where it has been transported and accumulated and disposed of at different location. Sediment control practices a generally expensive to install, and difficult to maintain and the least desirable control practice.

## 6.2. On-Farm Practices

### 6.2.1. Farm and Ranch Roads

Roads are an integral component of rural lands and provide passage of equipment and vehicles into, around, and through farms and ranches. Well-planned roads allow for access to property without negatively impacting the surrounding environment. Roads not properly located or constructed may contribute to sediment load in streams and waterways. In-road rilling and sheet erosion are two forms of erosion that occur on roads. Additionally, roads that are actively eroding can intrude into field edges causing loss of arable land. Proper road construction and placement can reduce water induced soil erosion. However, erosion from access roads can contribute up to two times as much as soil loss from fields that enters streams or drainage ways from upland area.

There are several ways to ameliorate erosion from access roads. Generally all of the practices are intended to slow and control runoff of water from access roads, releasing at a point where it does not cause off-road erosion. Water bars are low berms placed across roads to divert water from the roadway and onto the adjacent land. Rolling dips are similar to water bars, but are much wider and are below the grade of the road. Culverts take flow from a roadside ditch and allow the water to cross under the road. Roadside ditches can be planted with perennial grasses to reduce erosion and increase the infiltration capacity of the ditch itself. The road can also be vegetated for the winter when access is not feasible or desired, or recontoured and revegetated for permanent closure.

**Waterbars.** A waterbar is "…a shallow ditch excavated at an angle across a road or trail to drain surface runoff. Waterbars are usually built on seasonal or temporary roads which are to receive little or no traffic during the winter" (Weaver and Hagins, 1994). Waterbars ideally should be placed at an angle between 30 and 45 degrees from the line perpendicular to the direction of the down hill flow of water. Waterbars can be constructed from native material or imported materials such as asphalt or concrete. Figure 6.1. illustrates the general dimensions of a water bar.

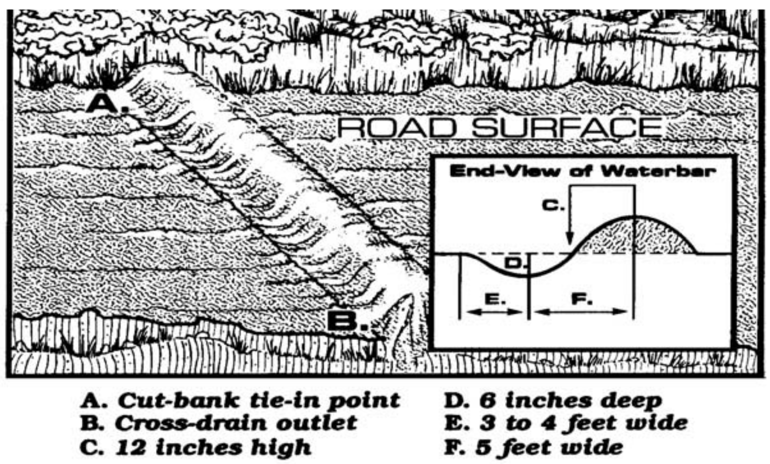



Figure 6.1 Typical Water Bar Dimensions
(adapted from SCCRCD, 1998)

Water bars constructed from materials such as concrete or asphalt can be of a lower height, but should be keyed into the road base 6-8". The drawback of waterbars is that they will greatly impact the speed of travel on the road. In the case of waterbars that are installed only for the rainy season, this is not an issue. In the case of waterbars that are constructed of permanent materials, this is a consideration. Waterbars must be maintained during the rainy season to ensure proper performance. Maintenance duties include: removal of obstructions to the outlet and reconstructing washouts. The cost to install waterbars is presented below in Table 6.1.

Table 6.1. Cost Estimate for Installation of Waterbars

| Description | Units | Quantity | Unit Cost | Total |
|---|---|---|---|---|
| 1. Installation Costs | | | | |
| Farm tractor w/scapper | hr. | 2.00 | 80.00 | $ 160.00 |
| Labor | cy | 0.20 | 12.00 | $ 2.40 |
| | | | Total Cost = $ | $ 162.40 |
| 2. Annual Maintenance | | | | |
| labor to maintain and repair | hr. | 1.00 | 12.00 | $ 12.00 |
| tractor w/scaper to remove | hr. | 0.50 | 80.00 | $ 40.00 |
| | | | Total Cost = $ | $ 52.00 |
| 3. Average Annual Cost | | | | |
| Installation cost ($162 x 1.08125) | | | | $ 175.00 |
| Annual Maintenance | | | | $ 52.00 |
| **Total Average Annual Cost** | | | | **$ 227.00** |

**Notes:**

1. Expected practice life is 1 year
2. Amortization factor (8.125%) for 1years = 1.08125
4. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
5. Costs Adjusted to 2002

**Rolling Dips.** An alternative to the waterbar is the rolling dip. "Rolling dips are simply breaks in the grade of a road. They are sloped either into the ditch or to the outside of the road edge to drain and disperse the road surface runoff. Rolling dips are installed in the road bed as needed to drain the road surface and prevent rilling and surface erosion… and are most frequently used on outsloped roads. As a road becomes steeper, rolling dips should be made deeper and placed at a steeper angle to adequately capture and divert road runoff." (Weaver and Hagans, 1994).

The advantage of the rolling dip is that it allows for year round use and has a lower cross section than a water bar, which allows for a higher speed of travel and vehicles with lower clearance to pass. A rolling dip is ideally constructed during the construction of the road, but can also be added at a later date. The depth of the rolling dip should be about 6-12" below the finish grade of the road. The axis of the channel of the drain should be between 30 and 45 degrees off of perpendicular to the flow of the water down the road. The disadvantage using rolling dips is that they have a large "footprint" on the road; the length of the footprint can be between 40 and 75 feet. Figure 6.2. shows some of the construction details of a rolling dip.

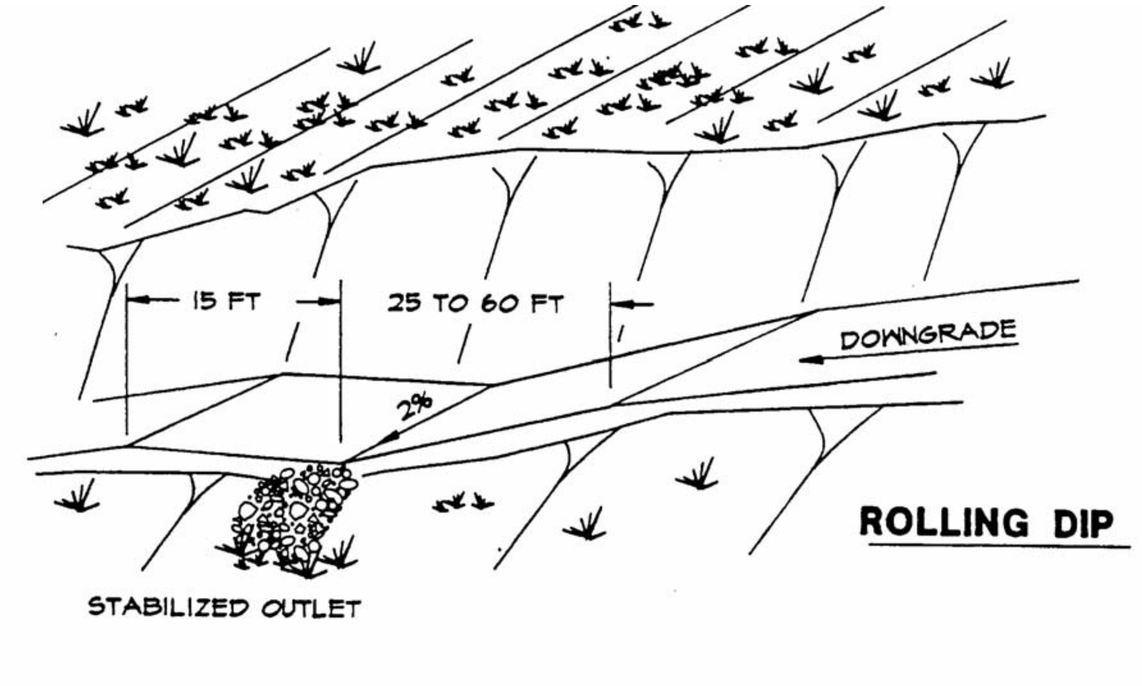



Figure 6.2 Rolling Dip Configuration
(adapted from SCCRCD, 1998)

The spacing between waterbars or rolling dips is a function of the slope of the roadbed and the erodability of the soils. The spacing distance of the waterbar/rolling dips decreases as the slope of the road or the soil erodability increases, as shown in Table 6.2.

Table 6.2. Spacing of Waterbars or Rolling Dips
(Adapted from SCCRCD, 1998)

| Slope (%) | Spacing (feet) | Spacing on highly erodable soils (feet) |
|---|---|---|
| <5 | 125-200 | 100 |
| 5-10 | 100-150 | 75 |
| 10-20 | 75-100 | 50 |
| 20-35 | 50-75 | 25 |
| >35 | 25 | 25 |

**Culverts.** To safely convey water from the inside to the outside of the roadbed, a culvert can be installed. Culverts should be sized to handle at least a 10-year 24-hour storm. An energy dissipater should be installed below the outlet of the culvert to reduce scour and erosion below the pipe. When installing a culvert a registered civil engineer or a certified erosion and sediment control specialist (CPESC) should be consulted to locate and size the culvert.

Undersized culverts are prone to clogging and if they become clogged can cause more damage than they were installed to prevent. Blocked water will pass over the road instead of along its intended direction typically resulting in severe erosion and damage to the road.

**Energy Dissipators.** Water that is diverted off of the road into a roadside ditch or outlet is changed from sheet flow to concentrated flow and will have a higher erosive potential. Outflow water should be released onto a velocity dissipation apron. As a generalization, velocity dissipaters are constructed with large stone, 6-12" diameter rip- rap, to absorb the energy of the falling water. The rip-rap is placed over filter fabric. The filter fabric serves the purpose of keeping fine soil particles from moving up into the rip- rap, and keeps the rip-rap from migrating down into the soil. The area immediately adjacent to the velocity dissipater can be vegetated with woody or herbaceous vegetation such as willows, grasses, sedges, or rushes. The illustration below shows some variations on velocity dissipaters. A revegetation specialist should be consulted on selection of plant species appropriate to the site.

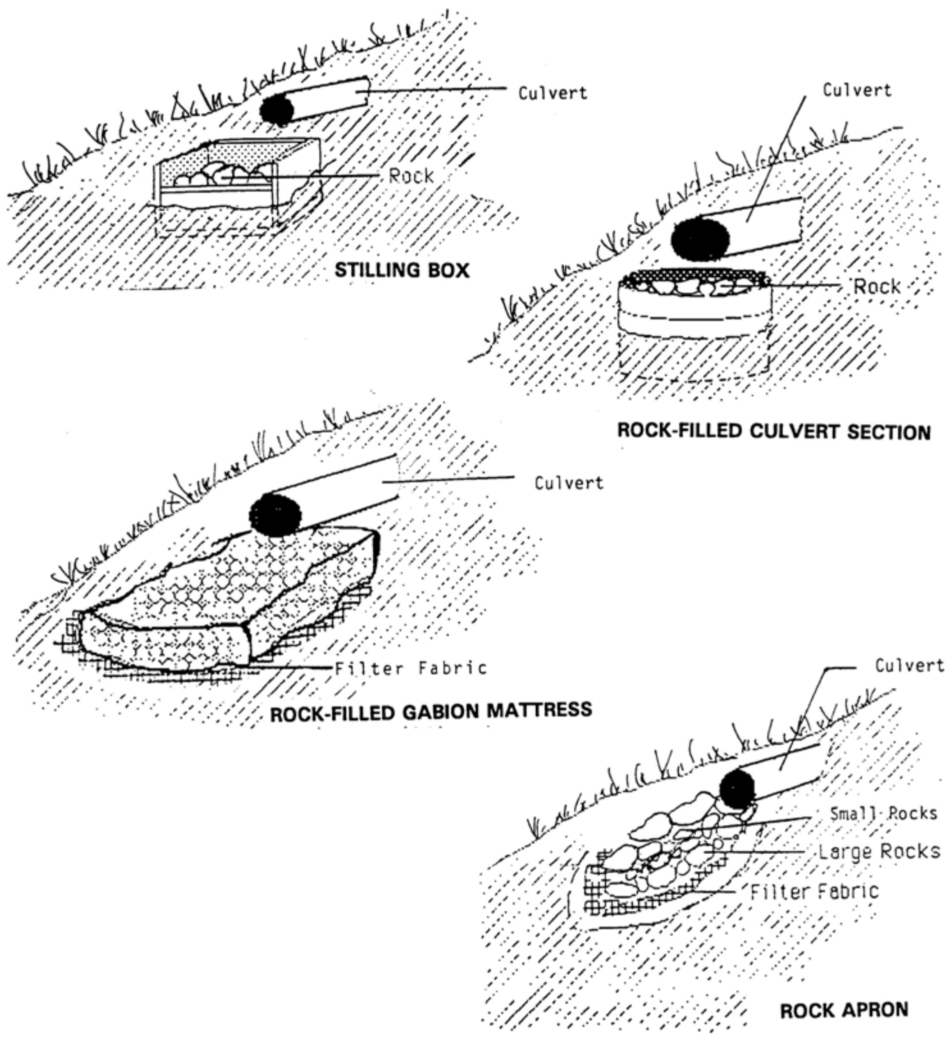



Figure 6.3 Velocity Dissipaters
(Adapted from SCCRCD, 1998)

**Vegetated Roads.** Revegetating access road surfaces during the winter is becoming an accepted practice to establish annual or perennial grasses on road beds to reduce sheet, rill and gully erosion As shown in Figure 6.4). Grass on winter roads is important because the vegetation provides a large root mass that protects the road from wash out, protects the bed ends from slumping, inhibits the growth of weeds, and enhances the water quality of lowland streams. The Santa Cruz County Resource Conservation District (SCCRCD) the RCD of Monterey County and the USDA Natural

Resource Conservation Service have produced a brochure entitled "*Controlling Erosion on Hillside Farm Roads"*, which provides erosion guidelines for hillside farms.

Figure 6.4 Vegetated Road

The cost estimate for vegetated road cover is presented in Table 6.3.

Table 6.3 Installation and Maintenance Cost for Vegetated Road Cover

| Description | Units | Quantity | Unit Cost | Total Cost/Acre |
|---|---|---|---|---|
| 1. Installation Costs | | | | |
| Labor--Hand Harrowing | hrs | 8.00 | 12.00 | $ 96.00 |
| Fertilizer (16-20-0) | cy | 0.20 | 300.00 | $ 60.00 |
| Spread fertilizer | cy | 2.00 | 12.00 | $ 24.00 |
| Seed (see below for alternative seeds/costs)[5] | lbs/ac | 80.00 | 0.35 | $ 28.00 |
| Labor to plant seed | hrs/ac | 2.00 | 12.00 | $ 24.00 |
| Mulch w/grain seeds | tons/ac | 2.00 | 120.00 | $ 240.00 |
| Labor to spread straw | hrs/ac | 8.00 | 12.00 | $ 96.00 |
| Labor to punch straw | hrs/ac | 4.00 | 12.00 | $ 48.00 |
| | | | Total Cost = $ | $ 616.00 |
| 2. Annual Maintenance | | | | |
| Apply semi-annual fertilizer | lbs/ac | 250.00 | 0.20 | $ 50.00 |
| labor to spread fertilzier | hrs/ac | 1.00 | 12.00 | $ 12.00 |
| | | | Total Cost = $ | $ 62.00 |
| 3. Average Annual Cost | | | | |
| Installation cost ($948 x 0.56173) | | | | $ 512.00 |
| Annual Maintenance | | | | $ 62.00 |
| **Total Average Annual Cost Per Acre** | | | | **$ 574.00** |

**Notes:**
1. Expected practice life is 2 years
2. Amortization factor (8.125%) for 2 years = 0.56173
3. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
4. Costs Adjusted to 2002
5. Alternative Seeds:

| Seed | Unit | Quantity | Unit Cost | Total cost/acre |
|---|---|---|---|---|
| Cereal Rye Merced | lbs/ac | 80.00 | 0.35 | $ 28.00 |
| Common Barley | lbs/ac | 180.00 | 0.15 | $ 27.00 |
| Trios 102 | lbs/ac | 60.00 | 0.45 | $ 27.00 |
| California Broom & Creeping wild rye | lbs/ac | 24.00 | 8.75 | $ 210.00 |

### 6.2.2. Cover Crops

Cover cropping is used to improve soil fertility and stabilize soil during non-growing season or rotation. Typically the cover crop is not intended to be harvested for feed or sale. Cover cropping reduces soil erosion because the plant foliage intercept rainfall and absorb impact energy of rain drops and the roots of plants physically bind soil and increase the infiltration adsorption of water by increasing the soil porosity and organic matter into the soil (see Figure 6.5).

As with any new crop or practice, cover cropping requires a period of trial and error. The local Farm Advisor can be consulted for site specific recommendations. Cover cropping can provide many diverse and varied benefits, as well as, present some potential constraints, which must be considered when determining the use of this practice in the farm operation. Table 6.4 presents a summary of the benefits and constraints related to cover cropping.

Table 6.4. Benefits and Constraints of Cover Cropping

| Benefits | Constraints |
|---|---|
| • Prevents soil erosion<br>• Conserves soil moisture<br>• Protects water quality<br>• Reduces fertilizer costs<br>• Reduces the need for herbicides and other pesticides<br>• Improves yield by enhancing soil health | • Cover crops may be habitat for pest species.<br>• Cover crop uses soil moisture, in a dry farm situation this may be a consideration (however, research has also shown that cover crops can contribute to soil moisture during decomposition)<br>• If allowed to go to seed, the cover crop may become weedy, if use a re-seeding type crop<br>• Cover cropping may delay planting of winter or early spring crops |

Figure 6.5. Cover Cropping

## Performance

Cover cropping can substantially reduce the amount of soil loss from a field. Using the Universal Soil Loss Equation (USLE), soil loss estimates were calculated for the Felton-Lompico soil series in the study area under barren and cover cropped conditions. The results are summarized in Table 6.5 and Figure 6.6, which presents annual soil loss rates for cover cropped and barren soils for a range of slope classes ranging from 0 to 10 percent.

Table 6.5. Estimated Erosion Rates (tons/ac/year)
With and Without Cover Crops for Various Slopes
(Felton-Lompico Complex Soil Series)

| **Slope** | 0% | 2% | 5% | 10% |
|---|---|---|---|---|
| No Cover Crop | 0.100 | 0.312 | 0.955 | 2.62 |
| Cover Crop | 0.004 | 0.012 | 0.036 | 0.100 |

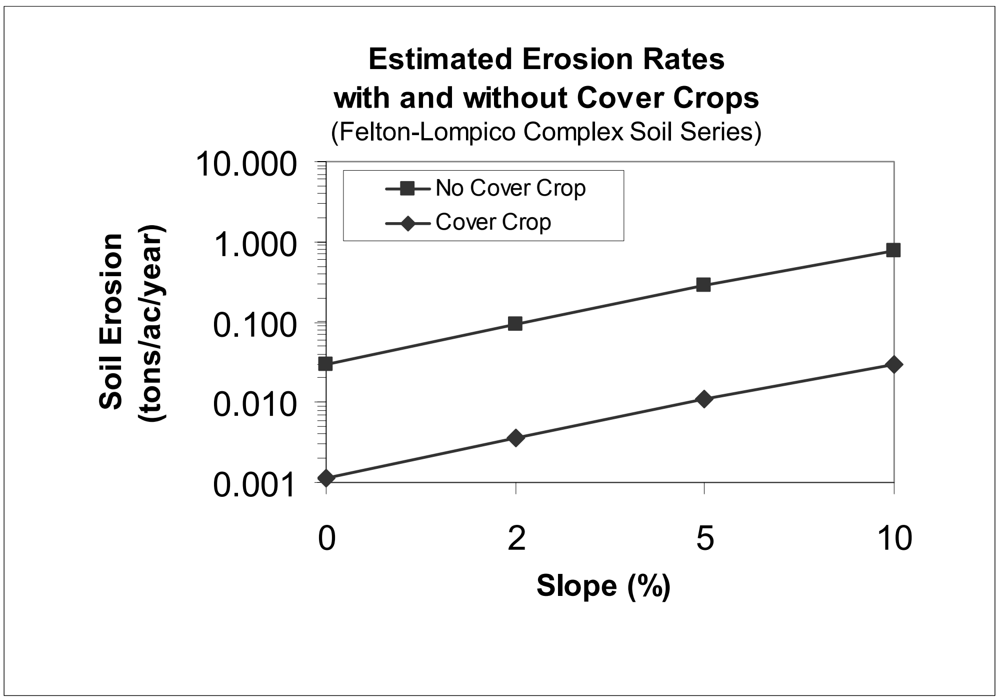



Figure 6.6 Estimated Soil Loss with and Without Cover Crops

A large amount of sediment is transported off of fields during the first significant rain events of the season when soils are uncompacted and bare. Therefore it is important to consider when and how the cover crop is established. Planting and irrigating a cover crop in October will significantly reduce the total amount of soil loss as compared to a non-irrigated cover crop that may be seeded in October, but does not become established until January. A non-irrigated cover crop will not have germinated by the time the first rains occur, whereas an irrigated cover crop will already have germinated and begun growth when the first storms arrive. The non-irrigated cover crop will have a lag time between when it is planted and when has grown enough to provide erosion control benefits. To illustrate this condition, an irrigated versus a non-irrigated cover cropped field were modeled using the “Universal Soil Loss Equation” (USLE) and the results are shown in Figure 6.5. The figure shows that the soil loss (in lbs) declines more rapidly in relation to the percent of field covered if the field is irrigated beginning in October.

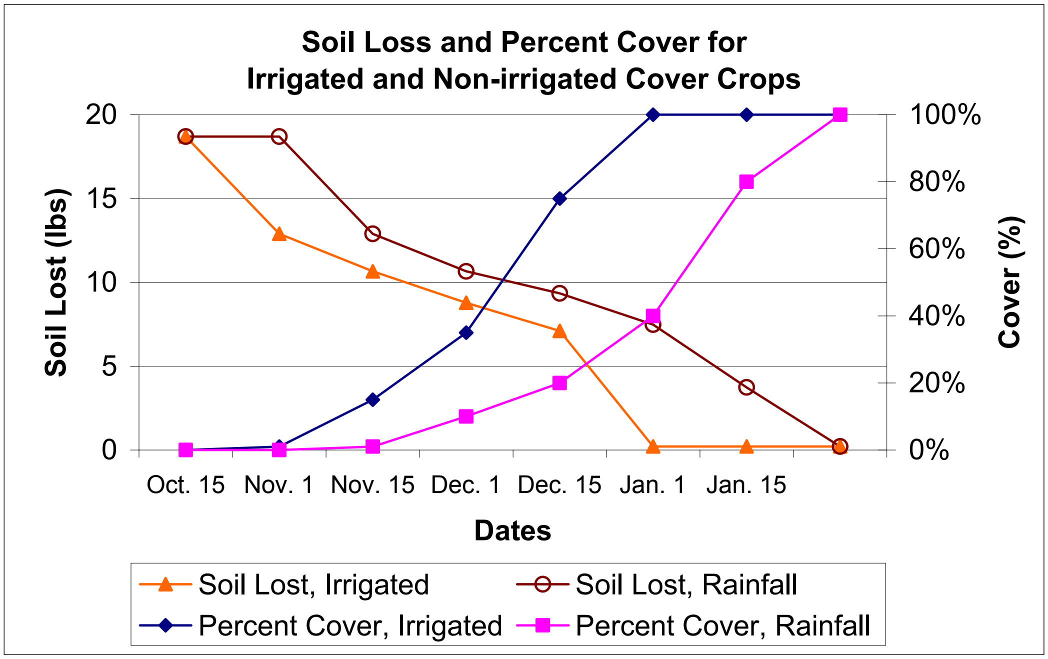



Figure 6.7 Soil Loss and Percent Cover for Irrigated and Non-Irrigated Cover Crops

**Costs**

Table 6.6 presents a cost estimate for cover cropping using a green manure mix.

Table 6.6 Cost for Cover Cropping (in $/acre)

| Description | Units | Quantity | Unit Cost | Total |
|---|---|---|---|---|
| 1. Installation | | | | |
| Disc w/harrow | hrs/ac | 0.67 | 80.00 | $ 53.36 |
| Cultipack w/D-4 Cat. w/8ft ringrollers | hrs/ac | 0.50 | 80.00 | $ 40.00 |
| Broadcast barley seed[4] | lbs/ac | 100.00 | 0.50 | $ 50.00 |
| | | | Total Cost Per Acre = $ | $ 143.36 |
| 2. Average Annual Cost | | | | |
| Cost per care = ($144 x 1.08125) | | | | $ 155.01 |
| Annual Maintenance | | | | $ - |
| **Total Average Annual Cost assuming a 3 year cycle for cover cropping** | | | | **$ 115.00** |

**Notes:**

1. Cover cropping assumed to occur 1 year out of 3-year cycle
2. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
3. Costs Adjusted to 2002
4. A large variety of cover crop types are available. UCCE crop advisors can assist in selection

Table 6.7 present costs for different seed mixes commonly used as cover crops in the Central Coast region.

Table 6.7. Cost for Cover Crop Seed

| Cover Crop Name | Seed Cost per Acre |
|---|---|
| 'Green Manure Mix' | $50 |
| Cow peas | $35 |
| Bell beans | $40 |
| Field Pea | $35 |
| Lana Vetch | $42 |
| Barley | $15 |

**Maintenance**

Maintenance considerations include: irrigation and cover crop incorporation. If the cover crop is planted significantly before the rainy season, it may require irrigation. After the rainy season, or before planting of desired cash crop, the cover crop must be incorporated into the soil. Incorporation usually includes mowing and discing.

After a cover crop has served its purpose for the winter, it must be tilled in. Often the cover crop is flail mowed, and then tilled in. The period required for the cover crop to break down after being tilled in may take up to two weeks. This may impact the first planting of a crop in the spring. This delay may have financial impacts that have to be balanced against the potential benefits of the cover crop.

**Additional Considerations**

Cover crops that are legumes require innoculant of bacteria called *Rhizobium sp.* to ensure nitrogen fixation and healthy growth.

### 6.2.3. Critical Area Planting

A Critical Area Planting (CAP) is vegetation, such as trees, shrubs, grasses, or forbs, planted in uncultivated edges and corners for a variety of functions including the control of erosion caused by water or wind or areas that are not cultivated, but are desired to be non-weedy. These plantings may be used along canal banks, levee edges, slopes between terraces, un-accessible slopes, or any other non-farmed location. Another purpose of a CAP is to out compete weeds that would otherwise move into field margins. Vegetation reduces runoff and erosion through increased soil porosity and soil organic matter.

Since these plantings are usually applied to areas too steep or erodable to farm, establishment of the vegetation may require handwork. Initial mowing or clearing may be required to remove any invasive species that are on the area to be planted. Once the plants are installed, the planting area requires occasional mowing and spot weeding in the first 1-2 years to allow the non-weedy vegetation to become well established.

**Performance**

The USLE was used to estimate the potential reduction in soil erosion for establishing Critical Area Plantings. The results of these calculations, presented in Table 6.7, that even a modest planting of short shrubs and grasses can significantly reduce soil erosion as compared to a fallow area partially planted in grasses or weeds.

Table 6.8 Estimated Reduction in Soil Loss by Critical Area Planting

| Treatment | Soil Loss (tons/acre-year) |
|---|---|
| 1. Fallow area with 40% groundcover with grasses | **9.06** |
| 2. 75% low woody brush (1.5' high) canopy and 80% grass groundcover | **1.00** |
| 3. 75% tall woody brush (6' high) canopy and 80% grass groundcover | **0.27** |
| 4. 75% tree canopy, 95-100% ground cover (grasses) | **0.27** |
| 5. Mature Critical Planting Area (CAP) | **0.09** |

## Suggested Plantings

Ideal vegetation for CAPs are long lived and self-propagating. Table 6.9 presents a partial list of native trees and shrubs recommended for CAPs. Trees and shrubs provide diverse root depths to hold soil and can shade out unwanted weedy species. The vegetation listed below was chosen based upon commercial availability, aesthetic appeal, and environmental suitability to the Lower Pajaro River watershed. A list of recommended native grasses is presented in the following section. Additional native species not listed below may be appropriate for planting in the project area. A local native plant nursery or restoration ecologist may be consulted for other plants, irrigation requirements, and plant spacing requirements.

Table 6.9 Native Trees and Shrubs Recommended for Critical Planting Areas

| **Common Name** | **Scientific Name** | **Mature Height** | **Mature Width** | **Spacing (On Center)** |
|---|---|---|---|---|
| ***Trees*** | | | | |
| Coast Live Oak | *Quercus agrifolia* | 30' | 40' | 60' |
| Buckeye | *Aesculus californica* | 20' | 30' | 40' |
| Sycamore | *Platanus racemosa* | 60' | 40' | 80' |
| ***Shrubs*** | | | | |
| Coffeeberry | *Rhamnus californica* | 12' | 10' | 20' |
| Toyon | *Heteromeles* | 10' | 10' | 20' |
| Ceanothus | *Ceanothus sp.* | 10' | 15' | 25' |
| Elderberry | *Sambucus* | 15' | 12' | 15' |
| Buckwheat | *Eriogonum* | 3-4' | 3' | 6' |
| Sticky Monkey | *Mimulus auranticus* | 3' | 2.5' | 6' |
| Ground cover | | | | |
| Blackberry | *Rubus ursinus* | 1' | 10' | 2.5' |
| Yarrow | *Achillea millefolium* | 1.5' | 1' | .5' |

### 6.2.4. Filter Strips

Filter strips are known by many names: buffer strips, vegetated buffer strips, and streamside management zones. All of these names refer to a swath of vegetation, generally herbaceous, that is established on the lower edge of fields or on fields and banks, adjacent to waterways or streams. For simplicity, only the term "filter strip" will be used in this section. One description of the mechanisms in a filter strip is "…A filter strip allows runoff and associated pollutants to be attenuated before reaching surface waters via infiltration, adsorption, uptake, decay, filtration, and deposition." (Comerford, 1992). Filter strips are generally not designed to convey concentrated flow. Runoff moves across the filter strip not along its length. Grass waterways, described next, are designed to convey flow.

Filter strips work through two primary modes of action: physical filtration of sediment, and sorting of sediment. Filtration occurs through the blocking of sediment by the aboveground vegetation, and surface organic matter. Sorting of the sediment occurs as a function of size of sediment and velocity of the surface water. As the water passes through the vegetated strip the velocity declines and the particles fall out of the water column. The performance of the filter strip functions improves if the runoff enters the filter strip as sheet flow; so that runoff spread is spread evenly over the entire surface of the area and not concentrated flow. Coarse-grained and fibrous materials are filtered more efficiently than fine-grained and soluble substances. Filter strips work well under design conditions, but when flooded or overloaded they may release a slug of pollutants into the surface water. Table 6.10 presents a summary of the potential benefits and constraints of the use of filter strips.

Table 6.10 Benefits and Constraints of Filter Strips

| Benefits | Constraints |
|---|---|
| • Reduces export of sediment bound pollutants and sediment<br>• Slows water runoff and reduces downstream damage<br>• Reduces downstream flooding<br>• Stabilizes stream-banks<br>• Establishment of natural vegetation.<br>• Improves air quality<br>• Adds visual aesthetics to the landscape | • Removes land from production<br>• Potential weed refuge<br>• Requires maintenance of vegetation |

**Design Considerations.** Filter strips are shaped to drainage grade. Filter strips should be graded to uniform slopes to provide sheet flow across the strip of vegetation and should not be used to convey concentrated flows along its length. If necessary topsoil should be spread and seedbed prepared. The seedbed should be fertilized, seeded and mulched with straw and the mulched anchored. The filter strip should be irrigated for establishment and as necessary for growth. Filter strips should be maintained by periodic fertilization and over seeding as necessary to maintain vigor. Filter strips should be mowed periodically if there is any fire hazard.

**Filter Strip Width.** Recommended widths for filter strips depend on slope of the field, soil types, cropping system and type of pollutants. Recommended widths range from 25 to 300 feet.

Accounting for slope variation, the width of the filter strip when the base width of the filter strip is 25 or 50 feet on relatively level land the width of the filter should be increased by 2 feet to 4 feet for every 1% increase in slope, respectively.

**Vegetation.** Generally, technical information pertaining to filter strips does not recommend specific plant species. Based on the cropping systems used in the Lower Pajaro River watershed, native grasses in most instances would be appropriate for use in a filter strips. In general, the vegetation of a filter strip should be herbaceous, like grass. Native grasses are recommended because they will not escape and become weeds, they are adapted to the region. Native grasses are also deep rooted providing the increasing soil porosity necessary for infiltration of runoff. Several species spread by rhizomes and are easily propagated where desired and once established will not require additional water. Table 6.11 presents a list of recommended grass species appropriate for filter strips. For additional species the RCD, UCCE and/or native plant nursery can be consulted.

Table 6.11 Recommended Grasses for Filter Strips

| Name | Latin Name | Seeding Rate ($lb/1000ft^2$) | Cost/ Lb | Plug Density: O.C. and Plants per $1,000ft^2$ | Cost per 125 plugs |
|---|---|---|---|---|---|
| Blue Wild Rye (R) | *Elymus glaucus* | .2-.9 | High: 30.00<br>Low: 11.00 | High: 5100<br>Low: 1300 | $15.00 |
| Meadow Barley | *Hordeum brachyanther –um* | .7-.9 | $17.00 | High: 5100<br>Low: 1300 | $15.00 |
| June Grass<br>(R, slowly) | *Koelaria macrantha* | 2.0 | $45.00 | High: 5100<br>Low: 1300 | $16.00 |
| Creeping Wild Rye (R) | *Leymus triticoides* | .2-.6 | $48.00 | High: 5100<br>Low: 1300 | $0.85<br>(LT 6) |

Notes: (R=Rhizomatous). Note: High density is 6" O.C., low density is 12" O.C.

## Performance

Dillaha (1996) reported that filter strips can reduce sediment load in shallow sheet flow by 90%. Additionally Dillaha notes that 91% of the sediment load and 37% of the clay-sized particles were removed in the first .6m (2') of the filter strip. USEPA (1993) reports that filter strips remove approximately 65% of sediment.

## Costs

Table 6.12 presents the unit cost for installing and maintaining an acre of filter strip in the edge of a field.

Table 6.12. Installation and Maintenance Costs for Filter Strips

| Description | Units | Quantity | Unit Cost | Total |
|---|---|---|---|---|
| 1. Installation | | | | |
| Shape to grade beds (D-4 Cat) | cy/ac | 200.00 | 2.50 | $ 500.00 |
| Disc w/harrow | hrs/ac | 0.67 | 80.00 | $ 53.36 |
| Cultipack | hrs/ac | 0.33 | 80.00 | $ 26.66 |
| Seed | lbs/ac | 6.00 | 8.00 | $ 48.00 |
| Mulch w/grain straw (see practice) | tons/ac | 2.00 | 165.00 | $ 330.00 |
| Seeding labor | hrs/ac | 2.00 | 12.00 | $ 24.00 |
| | | | Total Cost = $ | $ 982.02 |
| 2. Annual Maintenance | | | | |
| 20% installation | % | 0.2 | | $ 196.40 |
| | | | Total Cost = $ | $ 196.40 |
| 3. Average Annual Cost | | | | |
| Installation cost ($982 x 0.14987) | | | | $ 147.18 |
| Annual Maintenance | | | | $ 300.00 |
| **Total Average Annual Cost Per Acre** | | | | **$ 447.18** |

**Notes:**

1. Expected practice life is 10 years
2. Amortization factor (8.125%) for 10 years = 0.14987
4. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
5. Costs Adjusted to 2002

### 6.2.5. Grassed Waterways

Grassed water ways are water courses that are planted with perennial grasses or herbaceous vegetation. The grasses act to "armor" the soil and slow or prevent erosion. The roots of the vegetation also increase the porosity of the soil, increasing infiltration of water into the ground. The water ways can be road side ditches, drainage at the bottom of furrows, or any other drainage from fields. The purpose of grassed waterways is to reduce gully erosion and soil loss. As long as the slope of the ditch is not to steep and the velocity of the runoff in the waterwater is not too high vegetation can be established. Grassed waterways can also be used to convey water to filter strips, sediment control basins, or away from roadways.

There are two approaches to grassed waterways. The first is simply to plant grasses or other herbaceous perennials into an existing channel. The second is to design the channel from bare ground or reshape an existing ditch.

The NRCS typically sizes grassed waterways to convey runoff from the 10-year, 24-hour storm event. The side slopes of the channel should be 2 to 1 (2 horizontal to 1 vertical). The depth should be sufficient to contain the flow of the channel. The outlet of the ditch should be constructed with a velocity dissipater or sediment basin and/or other means to slow down the water and reduce downstream erosion, which can result in a headcutt migrating up stream forming a gully that conveys many tons of sediment.

The vegetation selected should be tolerant of occasional inundation with water.

Selected species for planting in grassed waterways: *Juncus balticus, Juncus bufonius, Juncus phaeocephalus, Hordeum brachyantherum,Elymus glaucus, Leymus triticoides, Aster chilenesis*. See Table 6.1 for specifics on some of these also used for filter strips.

**Costs**

The construction cost for a grassed waterway can range from $5 to $15 per linear feet. The range of cost is dependent on the width and depth of the waterway.

**Performance**

In general, a well-designed and maintained grassed waterway can be expected to remove 70 percent of the total suspended solids.

6.2.6. Contour Farming

The term "row arrangement" applies to orientation of the rows relative to the slope of the land. Arranging rows on contour or close to horizontal can greatly reduce the erosion of soil from the field. This occurs because the water leaving the field is slowed, and the erosive force is reduced. By contrast, rows that go up and down slope are more prone to soil loss. Since the water is delayed in its exit from the field, irrigation efficiency may be improved.

**Performance**

The importance of row arrangement can be illustrated in Figure 6.6., which presents an estimate of soil loss (lbs/acre/year) based on different furrow orientations for the Felton-Lompico soil complex on different slopes. The calculations were performed employing the Universal Soil Loss Equation (USLE).

For up and down furrows soil loss was almost 100 lbs/acre at 0 slope and over 1,000 lbs at 10% slope. Furrows arranged with contour lost less than 10 lbs and up to 100 lbs at 10% slope.

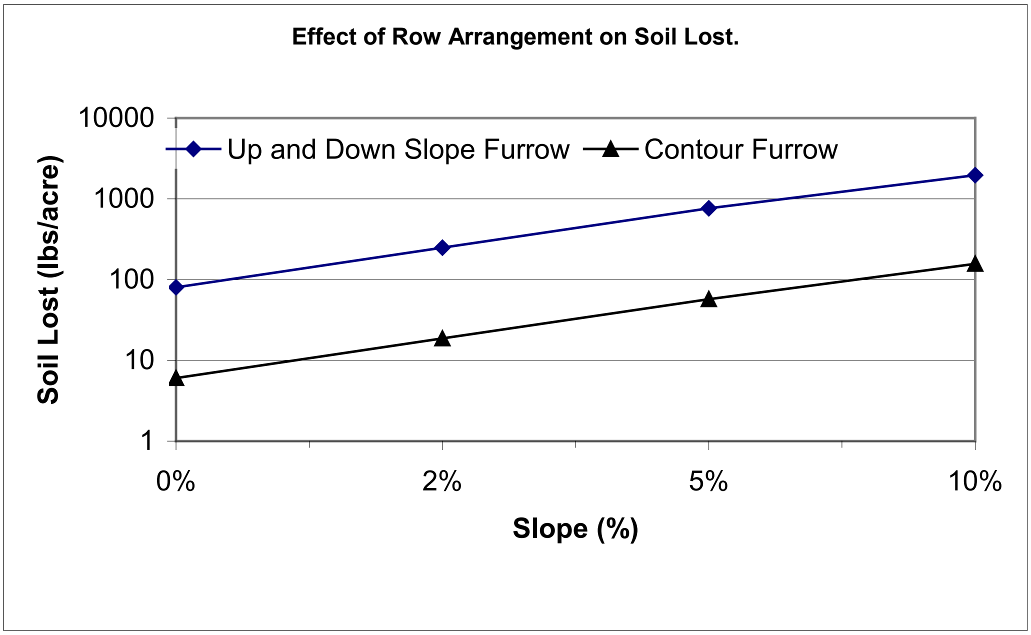



Figure 6.8 Comparison of Soil loss (lbs/acre/year)

**Costs**

There may some additional cost for contour furrowing, the expected incremental cost per acre is presented in Table 6.13.

Table 6.13. Incremental Cost ($/acre) for Contour Furrows

| Description | Increased Equipment Useage | Cost/Acre | Added Cost/Acre |
|---|---|---|---|
| 1. Intallation Cost | | | |
| List Beds using kubota-245 | 22% | 25.00 | 5.50 |
| Shape Beds and open furrow | 22% | 25.00 | 5.50 |
| Trasnplant and close furrows | 22% | 500.00 | 110.00 |
| Total Additional Cost Per Acre | | | 121.00 |
| 2. Annual Maintenance | | | |
| Bed and furrow maintenance | 22% | 25.00 | 5.50 |
| 3. Average Annual Cost | | | |
| Installation cost ($121 x 0.56173) | | | 68.00 |
| Annual Maintenance | | | 5.50 |
| **Total Average Annual Additional Cost per Acre** | | | **73.50** |

**Notes:**

1. Increased equipment use is approximately 22 percent
2. Expected practice life is 2 years
3. Amortization factor (8.125%) for 2 years = 0.56173
4. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
5. Costs Adjusted to 2002

### 6.2.7. Sediment Basins

The NRCS National Conservation Practice Standards defines a sediment basin as a basin to collect debris or sediment. The stated purpose of the basin is to relieve waterways downstream of fields of sediment burden. The sources of the water may be either irrigation or rainfall. Sediment basins are located at the bottoms of fields, and collect runoff water. After the basin, water may either go into a tailwater recovery system or be released into a local creek or waterway.

Consult a trained professional for proper sizing and location of the sediment basin. Available resources include NRCS staff, and consulting engineers or hydrologists. Considerations in basin design include: amount of land available to dedicate to the basin, area of land being drained into the basin, frequency and duration of storm events, and frequency of irrigation.

The construction of a sediment basin creates a zone of land that is in continual contact with water. Proactive vegetation removal of the basin will keep it from being invaded by weeds. Another method to control unwanted vegetation in basins is to maintain a depth of more than 5’ of water. Water at this depth prevents the growth of rampant vegetation such as cattails or tules. For a partial list of appropriate plants see the plant list in the above section “Grassed waterways”. Other appropriate plants might include willows, sedges, etc. Basin design should allow for periodic dredging and bank re-shaping. These activities require access for an excavator or backhoe. In many circumstances the basins should be designed to fully drain within 24 hours of a storm and not remain full of water.

Figure 6.9 Typical Sedimentation Basin

**Performance**

Use of sediment basins is one of the most effective methods of retaining the soil and nutrients carried by irrigation runoff. A properly designed sediment basin can settle up to 90% of the soil particles throughout the irrigation season. The performance of a basin is a function of the detention time (the amount of time the water is in the basin) and the basin geometry. The longer the water is in the basin the more fine sediment will fall out of suspension; however, increasing the dimensions of the basin may result in a loss of arable land creating potential trade offs between production and environmental protection.

Sediment basins can be used in conjunction with other conservation practices such as grass lined channels, tailwater recovery systems, velocity dissipaters, and filter strips, which act as “pre-treatment” systems to reduce the total sediment load and effectively reduce the overall size of the basin needed. Sediment basins can also be installed upstream of tail water collection systems (designed for re-using of water) to remove sediment and coarse particulate matter.

**Costs**

Table 6.14 presents the installation and maintenance costs for a sedimentation basin sized for a 10-acre strawberry farm.

Table 6.14 Installation and Maintenance Cost for Sedimentation Basin

| Description | Units | Quantity | Unit cost | Total |
|---|---|---|---|---|
| 1. Installation Costs | | | | |
| Escavation and Fill | cy | 877 | 6.00 | 5,262.00 |
| Grouted Cobble chute | cy | 8 | 30.00 | 240.00 |
| Concrete | cy | 2 | 100.00 | 200.00 |
| Toe drain 6 inch | lf | 22 | 8.00 | 176.00 |
| Filter fabric | sq. ft. | 30 | 2.50 | 75.00 |
| Gravel | cy | 5 | 35.00 | 175.00 |
| Lining 10 mil | sq. ft. | 1400 | 0.25 | 350.00 |
| Sand layer | cy | 30 | 15.00 | 450.00 |
| Cobble layer | cy | 30 | 15.00 | 450.00 |
| Riser 24" | lf | 5 | 18.00 | 90.00 |
| Concrete base | | | | 200.00 |
| CMP 18 inch | lf | 60 | 15.00 | 900.00 |
| | | | Total Cost = $ | 8,568.00 |
| 2. Annual Maintenance | | | | |
| Cleanout | cu | 580.00 | 2.00 | 1,160.00 |
| Repair damages | | | | 400.00 |
| | | | Total Cost = $ | 1,560.00 |
| 3. Average Annual Cost | | | | |
| Installation Cost = ($8,568 x 0.2518) | | | | 2,157.00 |
| Annual Maintenance | | | | 1,560.00 |
| **Total Average Annual Cost** | | | | **3,717.00** |

**Notes:**

1. Basin to serve 10 acres of strawberries.
2. Assumed erosion rate averages 70 tons/acre/year.
3. Expected life of basin = 5 years
4. Amortization factor (8.125%) for 5 years = 0.25128
5. Reference: USDA, 1984, *Strawberry Hills Target Area: Watershed Study Technical Report*
6. Costs Adjusted to 2002
7. Costs do not include any grading or other permits that may be required by County of Santa Cruz

## 6.2.8. Tailwater Ponds/Recovery Systems

Tailwater ponds/ recovery systems are designed to collect, store, and transport irrigation tailwater for reuse in a farm irrigation distribution system. The purpose is to conserve irrigation water supplies and improve water quality by collecting and reusing surface water. Water that flows off of the low end of a field is collected in a sump and reused for irrigation on the same or adjacent fields. Water may pass through a sediment catchment basin before it enters the tailwater pond and recovery system. In addition to collecting tailwater, tailwater ponds capture and store sediment.

As with sediment catchment basins, the banks of the tailwater ponds can be vegetated with plants appropriate to wetlands or marshes. For a partial list, see the list in the above section “grassed waterway”

Table 6.15 Benefits and Constraints of Tailwater Ponds

| Benefits | Constraints |
|---|---|
| • Reduces sediment leaving the field.<br>• Reduces agricultural drainage issues.<br>• Conserves irrigation water.<br>• Reduces weed seeds down-stream.<br>• Re-circulates silt onto field.<br>• May eliminate the need for additional conservation practices for sediment. | • Requires management.<br>• Relatively High construction costs.<br>• Possibly increased labor costs.<br>• May increase salt accumulation in soil or soil soluble salts.<br>• Tailwater pond takes small area of land out of production. |

**Costs**
The Yolo County Resource Conservation District estimates a range of $14,700 to $30,400 for the installation of a tailwater ponds and return systems

**Additional Considerations**

In addition to sediment collection, tailwater ponds can provide many other benefits. By capturing and reusing tailwater, water soluble nutrients can be reclaimed and reused. Tailwater ponds can be planted in a manner to create wildlife habitat.

### 6.2.9. Underground outlet

Underground outlets are pipes installed beneath the surface of the soil to collect surface water and convey it to a suitable discharge point. Underground outlets reduce erosion from fields, field margins, and ditches by placing concentrated water into a conduit and releasing it downstream in a controlled manner. Outflow from an underground outlet is typically released into a sediment basin or similar structure where suspended sediment can settle out. The pipe must be of sufficient size to carry the design flow of the system. Trash racks should be installed at the inlet of the pipe system and guards should cover the pipe outlet prevent rodents from nesting in the system. This practice can be used in conjunction with other practices such as vegetated roads, grass lined channels, sediment control basins, and filter strips.

Table 6.16 Benefits and Constraints of Underground Outlets

| Benefits | Constraints |
|---|---|
| • Drains surface waters and allows farming of previously damp areas.<br>• Reduces surface water induced erosion.<br>• Can be installed in areas where surface water conveyance is not practical or feasible. | • Requires extensive ditching and excavation.<br>• Outflow of water from pipes must be controlled, or water detained.<br>• Water does not receive the filtration that it may receive in a surface conveyance such as a grass-lined ditch. |

Figure 6.7 shows one particular arrangement of the inlet for an underground outlet. The basin that the underground drains can act as a sediment basin or, an underground outlet can drain a sediment catchment basin

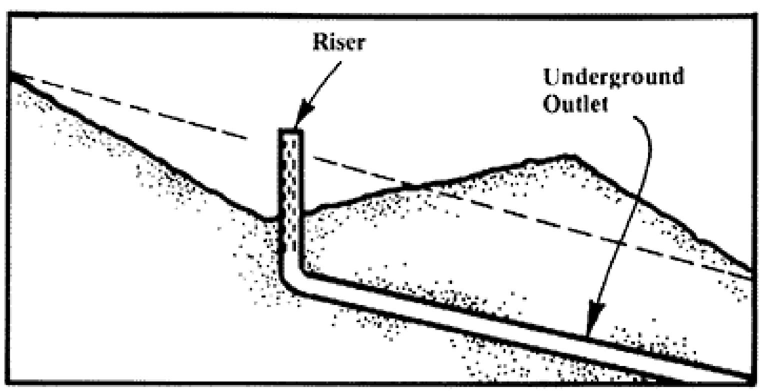


Figure 6.10. Typical Inlet Arrangement of Underground Outlet

**Costs**

The costs for installing underground outlets in a field is dependent on a variety of field conditions, including the size of the field the number of furrows, type of crop, type of mulch, slope and other factors that will dictate the length and size of pipelines installed. The estimated costs to install corrugated plastic pipe to drain one acre of row crops can range from $325 to $750 per acre for the furrow pickup line and approximately $1,500 for a 500 foot long conveyance line. Annual maintenance cost may range from $250 to $400 per acre.

## 6.2.10. Summary of Practices

Table 6.17 presents a summary of the nine practices described above, including the type of practice, the overall performance for erosion control and sediment removal, cost information and annual maintenance requirements.

Table 6.17. Summary of On-Farm Best Management Practices

| | Type of Practice | | | Overall Performance | | | Sediment Removal | | | | Cost | | | | Annual Maintenance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Practice | Erosion Control | Sediment Control | Runoff Control | Moderate | Good | Excellent | Moderate | Good | High | Sediment Removal Efficiency | Low | Moderate | High | Cost $/Acre | Low | Moderate | High |
| **Farm/Ranch Roads** | | | | | | | | | | | | | | | | | |
| Water Bars/Rolling Dips | | | X | | X | | | X | | -- | X | | | $225.00 | | X | |
| Culverts | | | X | X | | | | X | | -- | | X | | -- | | X | |
| Energy Dissipator | | | X | | | X | | | X | -- | X | | | -- | X | | |
| Vegetated Roadbed | X | | X | | | X | | | X | | | X | | $574.00 | | X | |
| **Cover Crop** | X | | | | | X | | | X | 85-90 | | X | | $115.00 | | X | |
| **Critical Planting Area** | X | | | | X | | | X | | -- | | X | | -- | X | | |
| **Filter Strips** | X | X | | | X | | | X | | 70-90 | | X | | $447.00 | | X | |
| **Grassed Waterway** | | | X | | X | | | | X | 70 | | X | | $5 - $15/LF | X | | |
| **Contour Farming** | X | | X | | | X | | | X | 80-90 | | X | | $75.00 | | X | |
| **Sedimentation Basin** | | X | X | | X | | | | X | 70-90 | | | X | $1,000.00 | | | X |
| **Tailway Ponds** | | | X | | X | | | | X | -- | | | X | $1,000.00 | | | X |
| **Underground Outlets** | | | X | | X | | | | X | -- | | | X | $325 - $750 | | | X |

## 6.3. Biotechnical Bank Stabilization

Biotechnical stabilization can incorporate hard structural elements and live vegetation to stabilize a stream bank. In streams these methods can be used to reduce velocities and shear stresses near the banks, reducing the risk of scour. On the slope vegetation can be used to slow overland runoff and increase the strength of the slope, in turn increasing the banks ability to resist erosion. As compared with traditional structural slope stabilization methods, biotechnical techniques are relatively inexpensive. Biotechnical methods are flexible techniques, which can be adapted for different sites. By employing vegetation into a bank stabilization method, with time the roots of the vegetation will become the main structural support of the bank or a portion of the bank. This allows the bank to be self-repairing, as older plants die new plants are established to replace them, providing long-term stabilization using active root structure of trees and shrubs, as opposed to a strictly structural alternative that will eventually need to be replaced. In many areas biotechnical slope protection can be superior to strictly hard protection using concrete or rip-rap. In addition to providing bank stabilization, the use of vegetation provides habitat in the stream and on the bank. Vegetation can also provide shade in the stream, reducing the water temperature and improving water quality (PWA, 1996). Biotechnical methods require monitoring for the first few years after construction, repairs may be needed and some plantings may need to be replaced until vegetation is well established.

### 1.1.1. Vegetated Rip-rap

Vegetated rip-rap is the method of planting live stakes within rip-rap during installation. Rip-rap is typically used as an energy dissipater for bank protection, decreasing velocities near the bank and trapping sediment. This method is often effective at the bottom of the stream bank, combined with "softer" measures that use more vegetation on the higher parts of the streambanks. The roots of the vegetation improve the stability of the rip-rap by preventing washout of fine soils and reinforcing the underlying soil (Gray and Sotir, 1996). Rip-rap of any size can be planted with live stakes, typically locally obtained willow stakes are used. Stakes are 1 to 3 inches in diameter and a length long enough to make good contact with the native soil and extend above the rip-rap at least 6 inches. In addition to slope stability, vegetated rip-rap provides riparian cover and wildlife habitat. Installation costs range from $60 to $100 a lineal feet of stream bank treated depending on site access and topography. Long-term maintenance costs are similar.

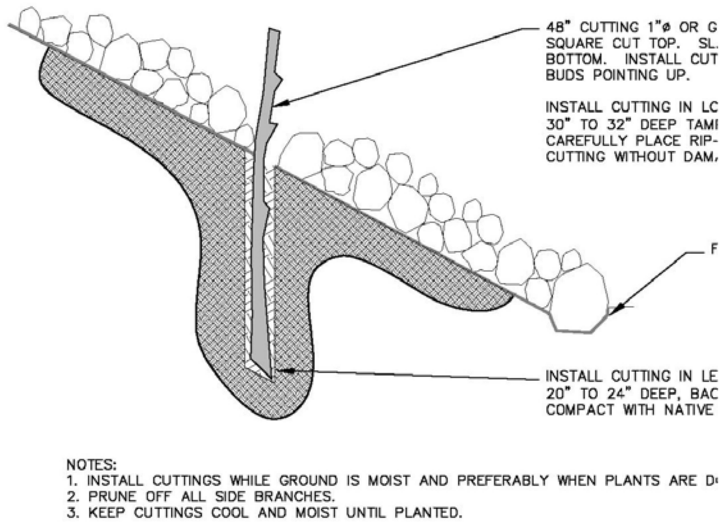



Figure 6.11 Typical Vegetated Rip-Rap

### 6.3.1. Vegetated Crib Wall

Vegetated "crib walls" provide protection against scour and undermining. Vegetated crib walls are constructed of untreated logs arranged in box like interlocking lifts or layers. Logs can be as small as 4" or as large as 18" in diameter (as shown in Figures 6.12 and 6.13). Between each lift live branches, typically locally obtained willow branches, are placed perpendicular to the slope. Branches should ½" to 3" in diameter and should have their butt ends in the soil behind the crib wall. The tips should stick out from the wall no more than one quarter of total length of the cutting. As each lift is constructed the crib wall and the cuttings shall be backfilled with a soil backfill mix. Once the vegetation is established and as the log cribs deteriorate with time, the vegetation provides the structural support. This type of structure provides a more natural method of bank stabilization where the bank is near vertical and extensive regrading the slope is not feasible. However, care must be taken to maintain the cross-section area of the stream to convey flood flows. The overall goal of a vegetated crib wall is to establish vegetation for long term bank stabilization. The installation of a vegetated crib wall ranges from $150 to $300 depending on site access, height of the wall and availability of willow cuttings.

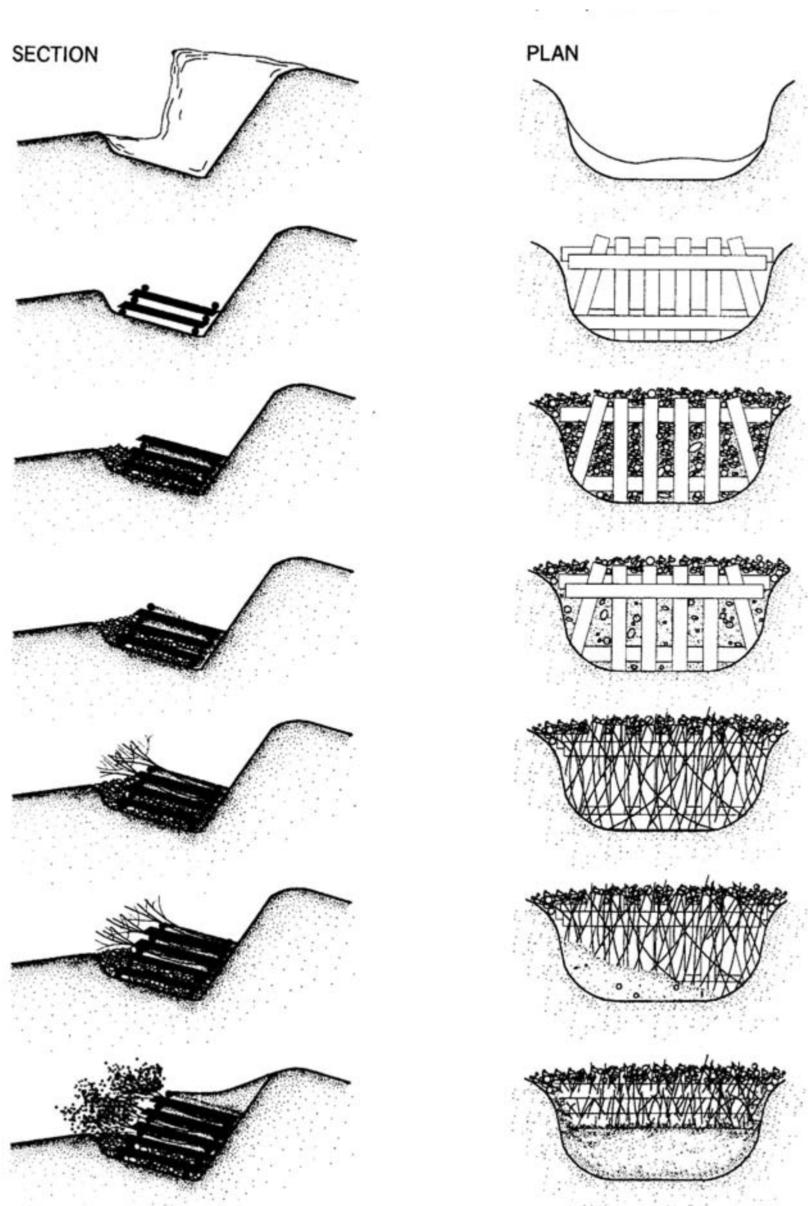



Figure 6.12 Typical Vegetated Crib Wall Construction
(Gray and Sotir, 1996)

Figure 6.13. Redwood Log Crib Wall with Willow Stakes

### 6.3.2. Willow Wattles/Fascines

Willow wattles and fascines are living erosion control barriers, and can be used for slope stabilization in road cuts, embankment fills, gullied areas, erosion in stream banks and other slopes. Wattles and fascines provide protection against surface erosion such as rills and gullies, however since roots do not penetrate deep into the slope they are less protective against mass movement.

Wattles and fascines consist of branches tied together in long bundles and placed in shallow trenches. They differ in that fascine bundles are constructed so that all the branches point downstream, additionally fascines are installed slightly up slope, which tends to result in more vigorous growth. Bundles are 6 to 12 inches in diameter and 5 to 30 feet in length. They are installed in shallow trenches, one half to three quarters of the bundle diameter, across the slope. Wattles and fascines are typically installed in a series of benches on a slope, in order to slow down runoff and collect sediment. To keep the bundles in place, live stakes, 2-3 feet in length, are installed both downslope and through the bundles to hold them in place. Mulching should be placed between rows for 1.5:1 slope and an erosion control blanket should be used for steeper slopes. Installation of fascines and wattles ranges from $45 to $75 per linear feet of bank.

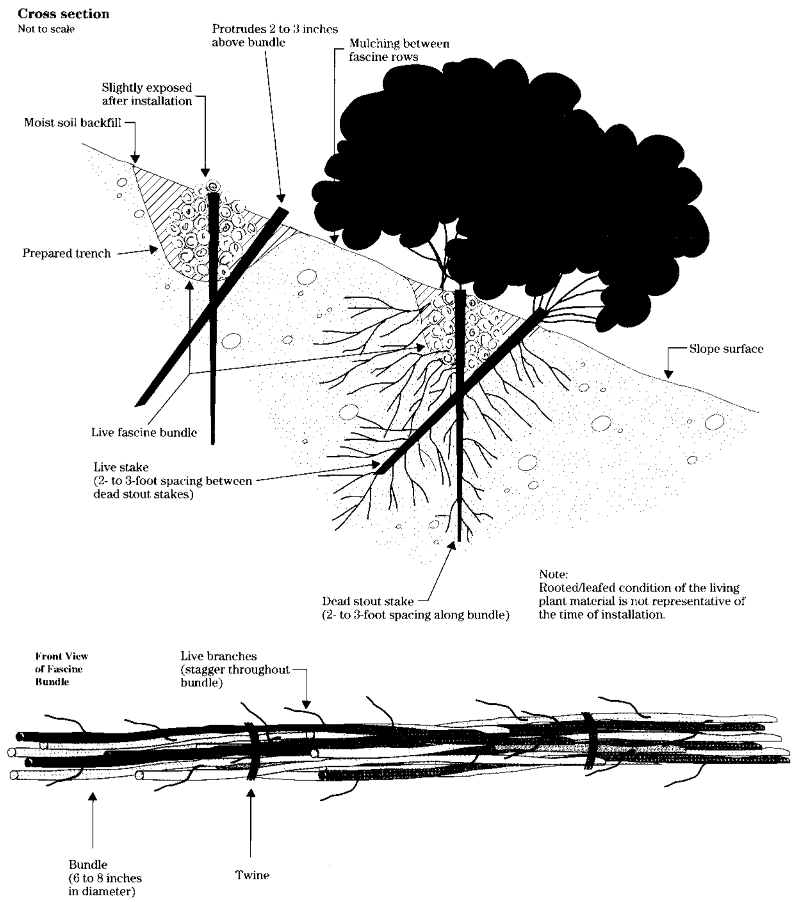



Figure 6.14 Typical Willow Fascine (NRCS, 2002)

### 6.3.3. Bank Reshaping

Bank reshaping can be done to reduce the slope of a bank; benches or terraces can be incorporated to assist in establishing vegetation. The maximum slope for a stabilized stream bank is typically 2:1, which will allow riparian vegetation to be permanently established on the bank. Terraced banks can be used either as a series of rows on a slope or as a single bench near the toe of a stream bank. When regrading a slope, installing a series of benches up the slope slows down overland stormwater runoff and provides a place for sediment and seeds to collect. Additionally, benches can be planted to initiate vegetation of a slope. A single bench near the toe of a stream bank can be used to define a low flow channel in a stream, to create a low elevation flood plain and provide a flat area for vegetation growth. The cost to grade and vegetate a slope ranges from $25 to $50 a linear feet.

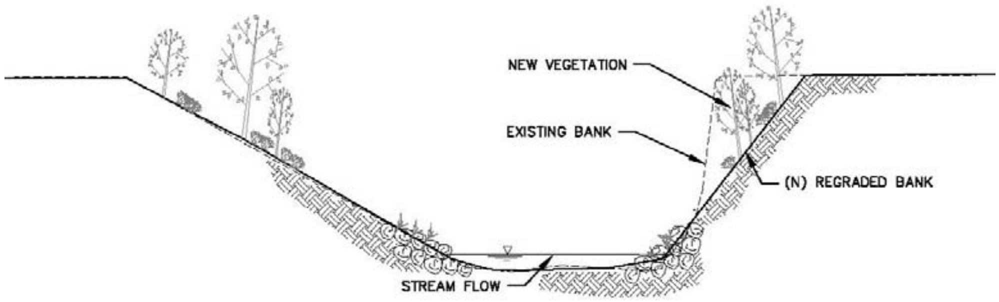



Figure 6.15 Bank Reshaping

Figure 6.16 Comparison of Bank Reshaping on Waterway

6.3.4. Log Bank Armor

Log bank armor can be used in a variety of ways. They can be installed as an energy dissipater to prevent scour near a stream bank. Logs can also be used to redirect flow away from a stream bank reducing the velocity of the water in the vicinity of the stream bank. Typically when placed near a stream bank they need to be secured in place using large boulders, a soil anchor system or other methods. Sediment will collect between the logs and the bank, providing a place for vegetation to establish.

Figure 6.17 Log Bank Armoring Using Redwood Log, Soil Anchors and Willow Staking

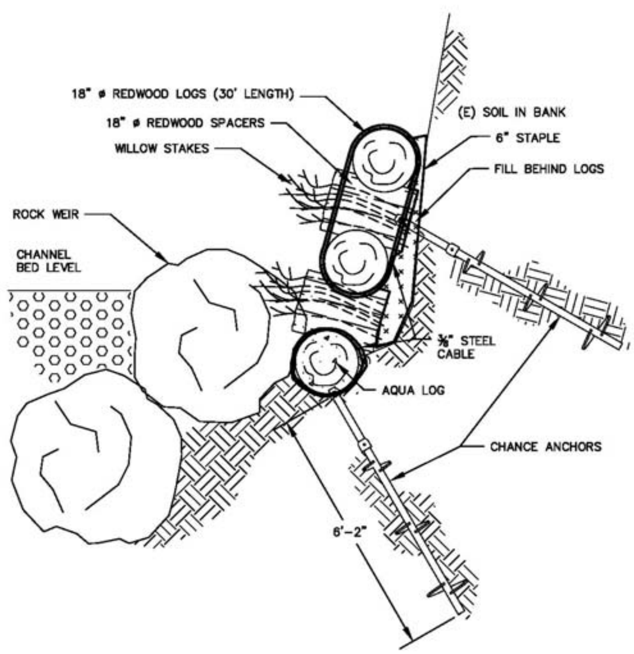



Figure 6.18 Log Bank Armoring Using Soil (Chance) Anchors and Willow Staking

# 7. DEMONSTRATION PROJECTS

## 7.1. Introduction

This section presents three demonstration projects that are recommended in the study area. The first two projects will involve stream bank stabilization measures and are located in the Green Valley and Coward Creek watersheds. Each project will be constructed utilizing different biotechnical bank stabilization methods to repair highly eroded banks. The projects will illustrate how the use and integration of vegetation and structural materials can be employed to stabilize and enhance steam and riparian conditions in the Pajaro Valley.

The third project presents alternative conceptual wetland and stream restoration plans. The project will potentially restore between 18 to 30 acres of freshwater wetlands and approximately 2,000 lineal feet of stream channel in the upper College Lake basin. This project presents a unique opportunity to restore a relatively large tract of open space as a multi-use facility that would restore wetland and riparian habitat, create environmental education and recreational opportunities, and provide an alternative source of local water supply. Presently, there are very few publicly accessible wetland and riparian parklands in the Pajaro Valley that are within close proximity to the city of Watsonville. As the Pajaro Valley continues to become more urbanized, access to parklands will become more vital to the growing population.

Each demonstration project describes the project setting, a brief problem assessment and baseline information, including topographic, hydrologic and water quality data, if available or pertinent. A conceptual restoration plan is presented that identifies the principal goals and design criteria for the proposed enhancement project. A project analysis is also provided that outlines the various tasks that would be needed to implement the project, including the engineering design, biotic review, permitting and pre- and post project monitoring and maintenance. Lastly, project cost estimates have been prepared for all project elements, from planning through post project monitoring.

## 7.2. Green Valley Creek Bank Stabilization Project

### 7.2.1. Project Setting

The project site is located on a farm specializing in floriculture and grows primarily rose stock in greenhouses. The property borders on Casserly Creek, a tributary of Salsipuedes Creek, located off of Casserly Road. Figure 7.1 presents a site vicinity map.

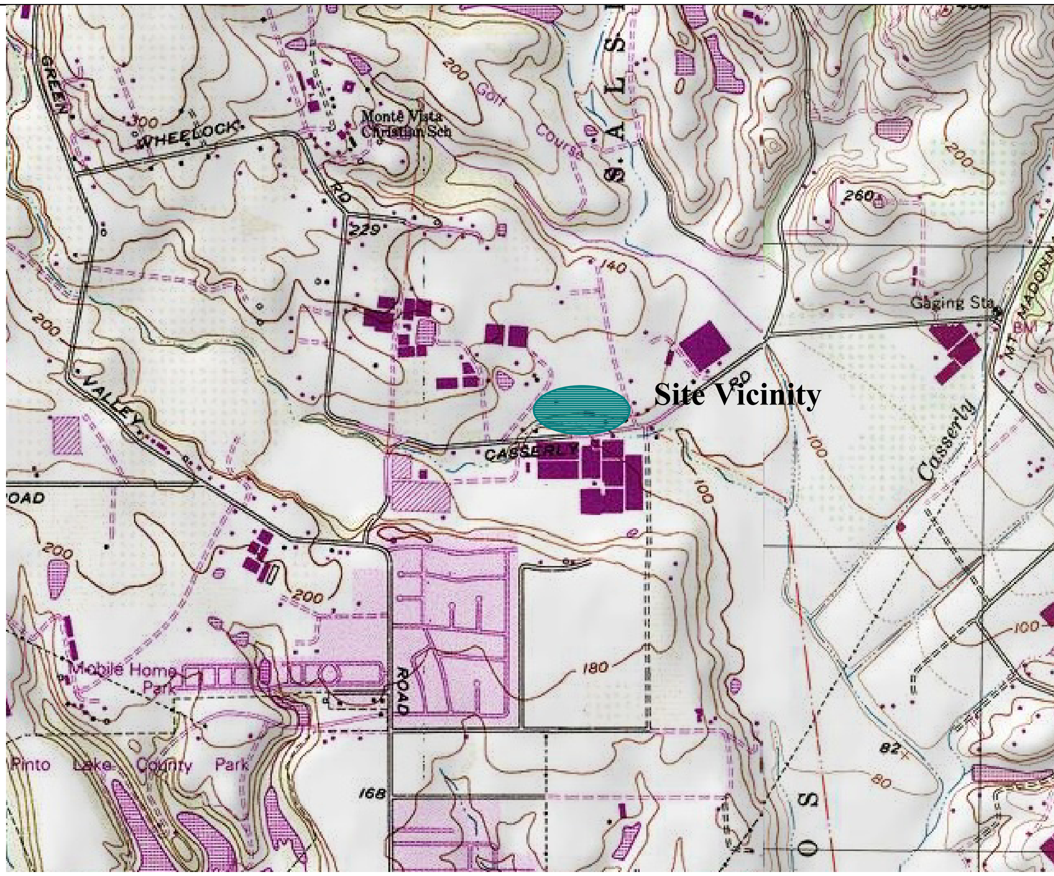



Figure 7.1 Site Vicinity Map

Casserly Creek meanders through the south side of the property. In this reach, the stream is deeply incised resulting in over steepened and unstable bank conditions in several sections of the stream on the property. Recently, the adjoining neighbor has installed a series of gabion basket walls to stabilize and armor the bank on the opposite side of the subject property. These hard structures can redirect high flows towards the opposite bank and if the bank is unprotected, the flows can result further erosion and bank instability.

There are two areas of concern, as shown in Figure 7.2 and 7.3. The first section is approximately 50 feet downstream of the bridge on Casserly Road crossing Casserly Creek (Site 1), and the second site (Site 2) is approximately 200 feet downstream of the bridge. At Site 1 the stream bank is severely eroded for approximately 40 feet. The channel is relatively deeply incised and the top of the slope drops vertical for approximately seven feet. Below this vertical drop the bank angles at a 1:1 slope to the stream. As a temporary bank protection measure concrete rubble has been placed on the lower portion of the bank. Due to the excessive erosion along the bank, there is very little riparian vegetation on that side of the stream.

At Site 2 the bank is nearly vertical and unstable. In this section of the stream, the channel is not as deeply incised as compared to the upstream site, and the top of the bank is approximately 6 feet above the channel. Due to the over steepened condition of the bank, erosion and slumping have occurred. Because of the steep slope of the bank there is virtually no vegetation on the bank.

Figure 7.2 Bank Conditions at Site 1

7.2.2. Conceptual Restoration Plan

**Project Goals.** The overall goals of the conceptual restoration plans for this project site include: providing long-term bank stabilization, reduce future erosion and sedimentation problems, and improve the riparian habitat in this section of the stream.

**Site 1.** To restore the bank to a more stable and natural condition, the proposed project will include removing concrete rubble, constructing a 60- foot long vegetated crib wall and reshaping and vegetating the top bank to a milder slope. The crib wall will be constructed from locally available willow logs, as shown in Figure 7.4. The crib wall will be constructed with live willow stakes; as the willows mature, the root structure will provide additional bank protection and erosion control. The top of the bank will be vegetated with native, locally available plants.

The proposed crib wall is 5 feet high extending from the water line to back edge of crib wall. The wall is approximately 50 feet long. The slope above the crib wall is to be graded to conform to the existing natural grade. The face of the crib is to have a batter of 6:1 (V:H). The crib wall main members are 6” to 8” diameter logs that will be live and not diseased. Each successive layer of cribbing will be pinned to the layer below with 8” or 12’’ galvanized bridge spikes. The bottom third of the wall is to have live willow branches (nominal diameter of 0.75” to 1”) layered into the header course. The toe of the crib wall is to have 12” to 18” diameter boulders keyed 10” into the stream-bed. The boulders will be about 18” to 24” deep. Willow stakes will be placed between the boulders on an approximate 3’ O.C. interval. Willow stakes will be between 3’ to 4’ in length and 0.75” to 3” in diameter.

Figure 7.3 Bank Conditions at Site 2

The top bank above the crib wall will be back filled to a 1 1/2 :1 (H:V) slope. The bare soil is to be re-vegetated with a combination of seed and container stock. An irrigation system will be installed at the time the site is re-vegetated and maintained until the plants are established.

The project will involve some rough and final grading. Preliminary grading estimates include 5 cubic yards of cut and 196 cubic yards of fill, including the crib wall and toe protection (riprap).

**Site 2.** The second site will include grading or laying back the bank to a 2:1 slope. The reshaped slope will be planted with native, locally plants. The toe of the bank will be protected from scour by installing with vegetated rip-rap, that will extend up the bank approximately three feet above the channel. Willow staking will be placed in between the riprap to provide long-term stability of the bank. Preliminary grading estimates indicate that approximately 115 cubic yards of cut will occur. A conceptual plan of this project is presented in Figure 7.5.

After the projects have been constructed, the new vegetation will need to be irrigated during the dry season to assure the successful establishment of the plants. Irrigation can be either through overhead spray or though drip emitters placed at the base of the individual plants.

The majority of the under-story of the project area is comprised of non-native noxious plants, and an assortment of annual grasses. The most significant of these are: German Ivy (*Senicio mikanioides*), Poison Hemlock (*Conium maculatum*), and Periwinkle (*Vinca major*). The grading suggested for the treatments of the bank failures represents a tremendous opportunity to eliminate these noxious weeds. The resulting bare slopes can then be re-vegetated with native species of the waterway vegetation (riparian) under-story. Examples of appropriate species include: Elderberry (*Sambucus sp*), Native Blackberry (*Rubus ursinus*), Mugwort (*Artemesia douglasiana*). Project plans will designate the complete plant pallete, spacing, sizes, etc.

### 7.2.3. Project Analysis

**DESIGN PLANS AND BIOTIC SURVEY**

Once the project has received funding, detailed design plans, planning and permitting activities will be required.

Design Plans
Detailed design plans and specifications will be required to construct the project. The detailed design plans will include the following:

- Site plan showing the location and extent of the of the project;
- Grading plan showing the limit of grading, cut and fill volumes, staging areas;
- Restoration plan showing the plans and details of the proposed improvements;
- Re-vegetation plan; and
- Construction specifications.

Biotic Survey
A qualified biologist will most likely be required to conduct surveys of the project site to document biological conditions for resource agencies that will require permits for the project.

**PERMITTING & REVIEW**

Because the project is located in a riparian corridor, several local, state and federal permits will be required to execute the project.

**Santa Cruz County.** The County of Santa Cruz will require that a grading permit and a riparian exception be obtained prior to their approval of the project.

**California Department of Fish and Game (CDFG).** A Streambed Alteration Agreement will be required. If the Santa Cruz County Resource Conservation District undertakes the project then a 1601 permit would be required, and if the private landowner applies for a permit, a 1603 permit is required.

**US Corps of Engineers (USCOE).** A USCOE Section 404 permit is required to carryout work within jurisdictional 'ordinary high water' and wetlands.

**Regional Water Quality Control Board.** A Section 401 Water Quality Certification from the Regional Water Quality Control Board (RWQCB) is required, which is part of the Section 404 permit process, but obtained directly from the RWQCB.

**Other Agencies.** Because the project will be conducted in a riparian corridor, the project will also be reviewed by other resource agencies, including the National Marine Fisheries Service and the US Fish and Wildlife Service.

### 7.2.4. Project Implementation

Project implementation will involve the regrading of the site, installation of the vegetated crib walls and revegetation of the site. The construction period of the project will most likely take between 3 to 6 weeks, depending on the final project design and on time restrictions imposed by the County of Santa Cruz and the California Department of Fish and Game.

### 7.2.5. Project Monitoring and Maintenance

A pre- and post project monitoring and maintenance program will be required to evaluate the performance of the enhancement project. The project will involve structural improvements, including construction of bank stabilization and erosion control measures, and site re-vegetation. All of which will require ongoing monitoring and periodic maintenance to achieve the long-term restoration benefits provided by the project.

Since the project will be constructed within a very dynamic hydrologic setting, the proposed structural improvements, erosion control and re-vegetation measures may experience damage, adjustments, and partial plant survival. A key element of the project will be to implement a long-term monitoring and maintenance program to evaluate the physical and biological condition of the project and to detect and correct situations requiring repair or modification.

The objectives of the monitoring and maintenance program are:

- Repair any minor damages quickly (i.e. erosion or gullies) to maintain the banks in a stable configuration and to avoid severe and costly damage resulting from deferred maintenance.

- Assure the restoration project is operating in compliance with the regulation and guidelines of the California Department of Fish and Game (CDFG), the National Marine Fisheries Service (NMFS), the California Regional Water Quality Control Board (RWQCB), and the County of Santa Cruz.

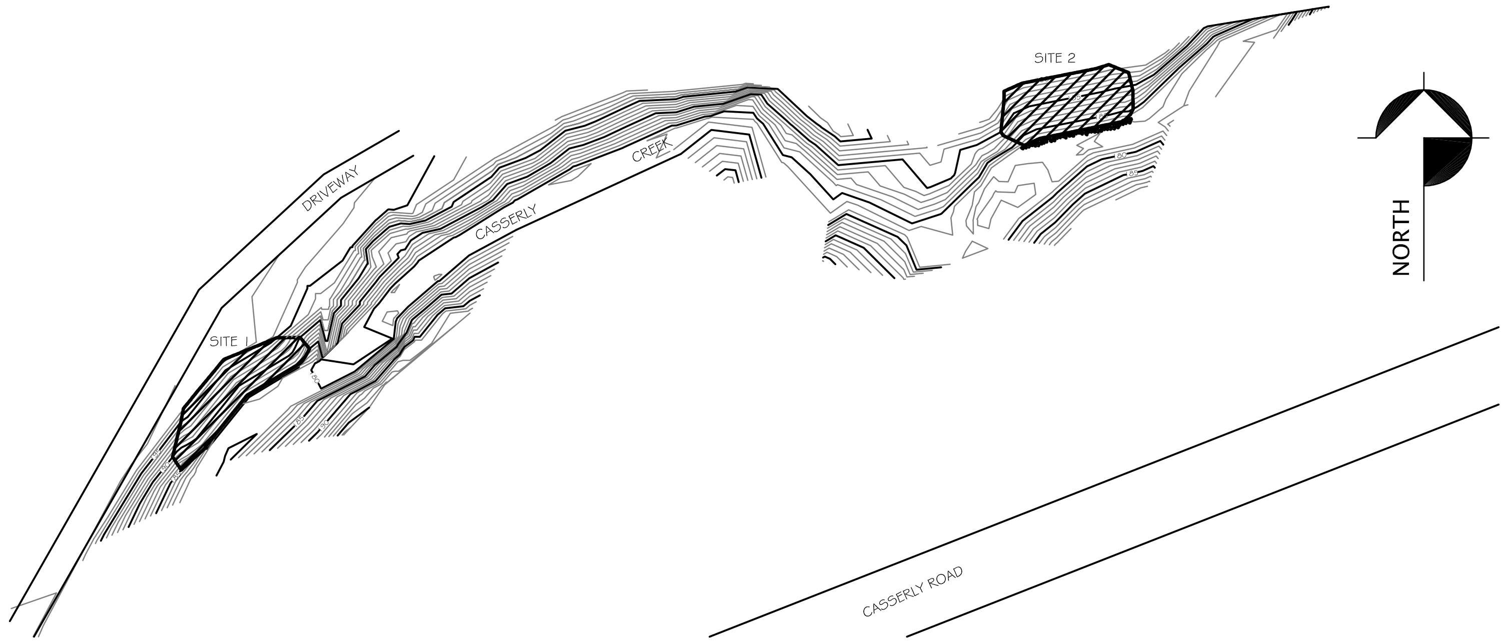
- Assess the effectiveness of the project.

### 7.2.6. Project Cost

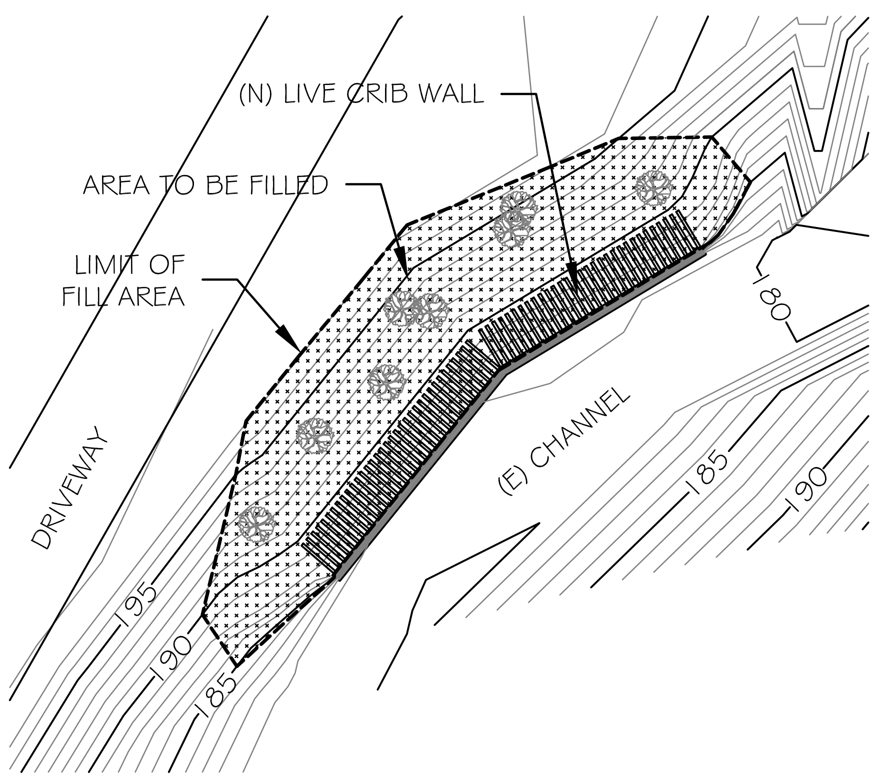
Table 7.1 presents a preliminary engineering cost estimate to design, permit and construct the proposed restoration project.

Table 7.1 Preliminary Project Cost Estimate

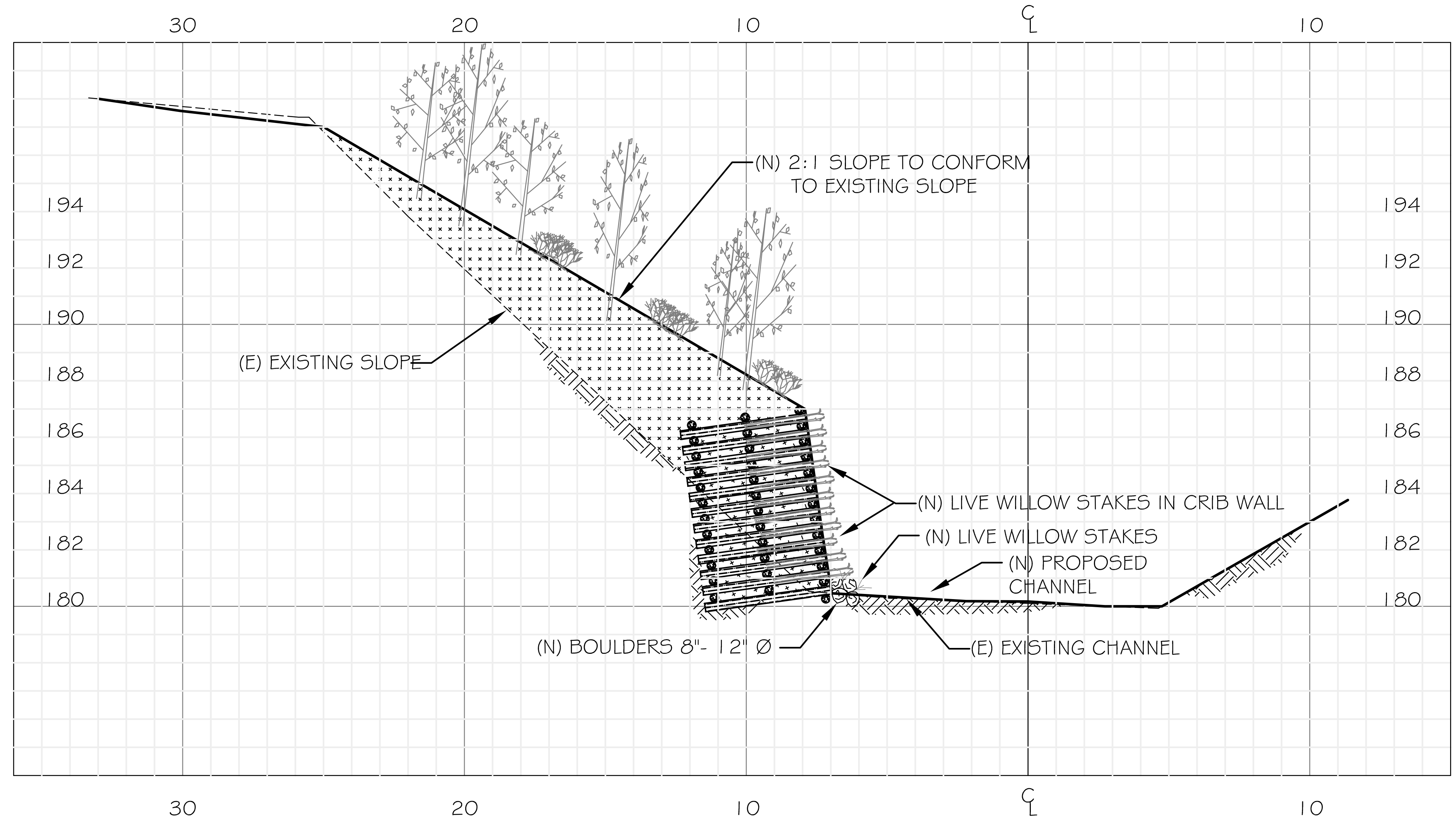
| Description | Costs |
|---|---|
| **1. Design and Permitting:** | |
| a. Engineering Design | $4,000.00 |
| b. Biotic Survey | $4,000.00 |
| c. Project Permitting (SCCRCD Staff) | $4,000.00 |
| d. Permit Fees | $5,000.00 |
| **2. Project Implementation** | |
| a. Site 1 Project | |
| i. Site Preparation | $5,000.00 |
| ii. Rough Grading | $2,000.00 |
| iii. 50 Foot Vegetated Crib Wall | $30,000.00 |
| iv. Final Grading and Erosion Control | $3,500.00 |
| v. Re-vegetation | $2,500.00 |
| b. Site 2 Project | |
| i. Site Preparation | $2,000.00 |
| ii. Rough Grading | $1,000.00 |
| iii. Bank protection and Erosion Control | $3,000.00 |
| iv. Re-vegetation | $2,000.00 |
| **3. Post Project Monitoring and Maintenance** | $5,000.00 |
| Total Project Sub-total = | $73,000.00 |
| Contingency (10%) = | $7,300.00 |
| **Total Costs** | **$80,300.00** |




PROJECT SITE MAP
SCALE: 1"=80'




PLAN VIEW
SCALE: 1"=20'




TYPICAL CROSS SECTION
SCALE: 1"=5'

PRELIMINARY GRADING VOLUMES:
CUT: 5 C.Y.
FILL: 196 C.Y.

FIGURE 7.4. SITE 1-CONCEPTUAL BANK STABILIZATION PROJECT

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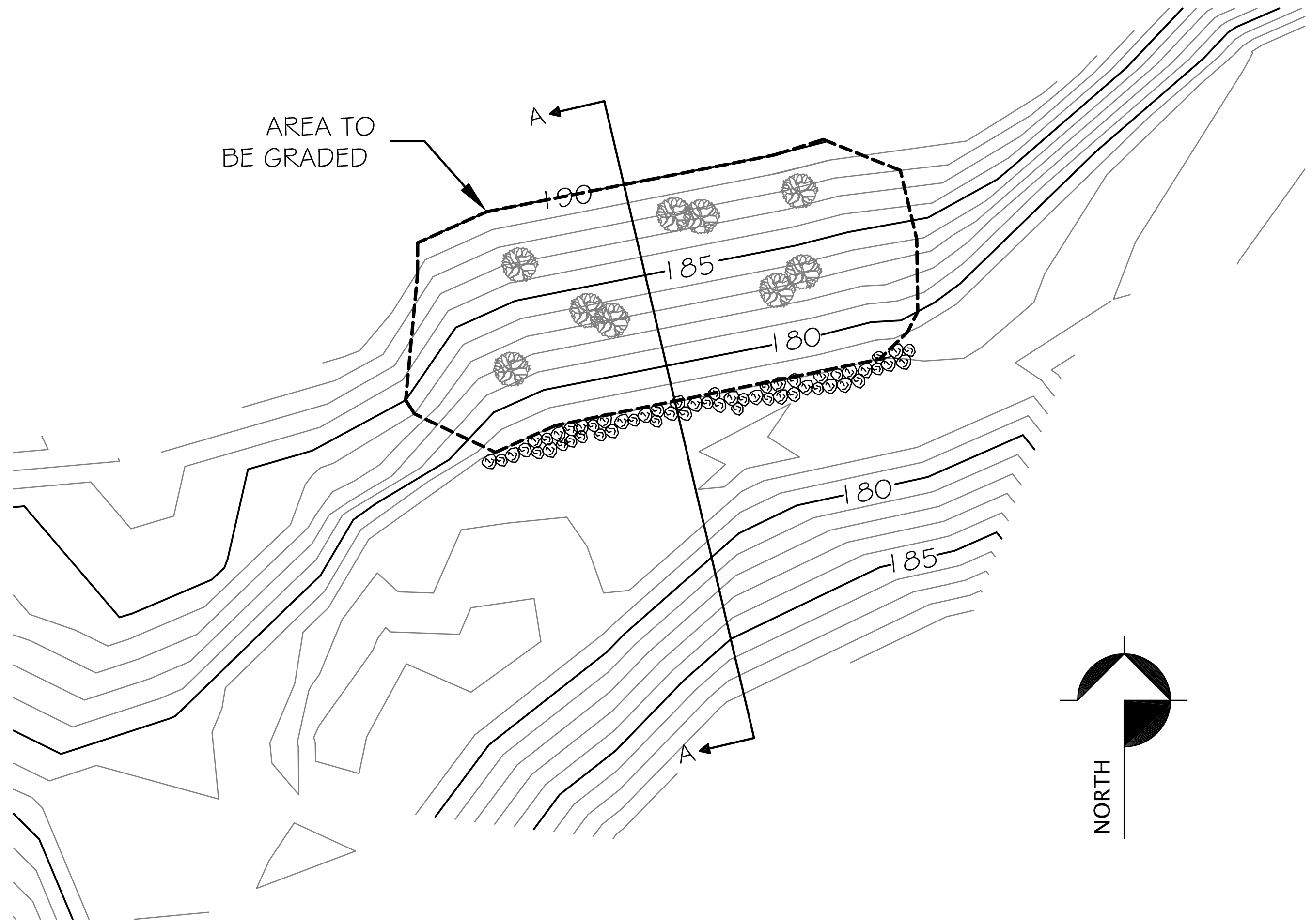
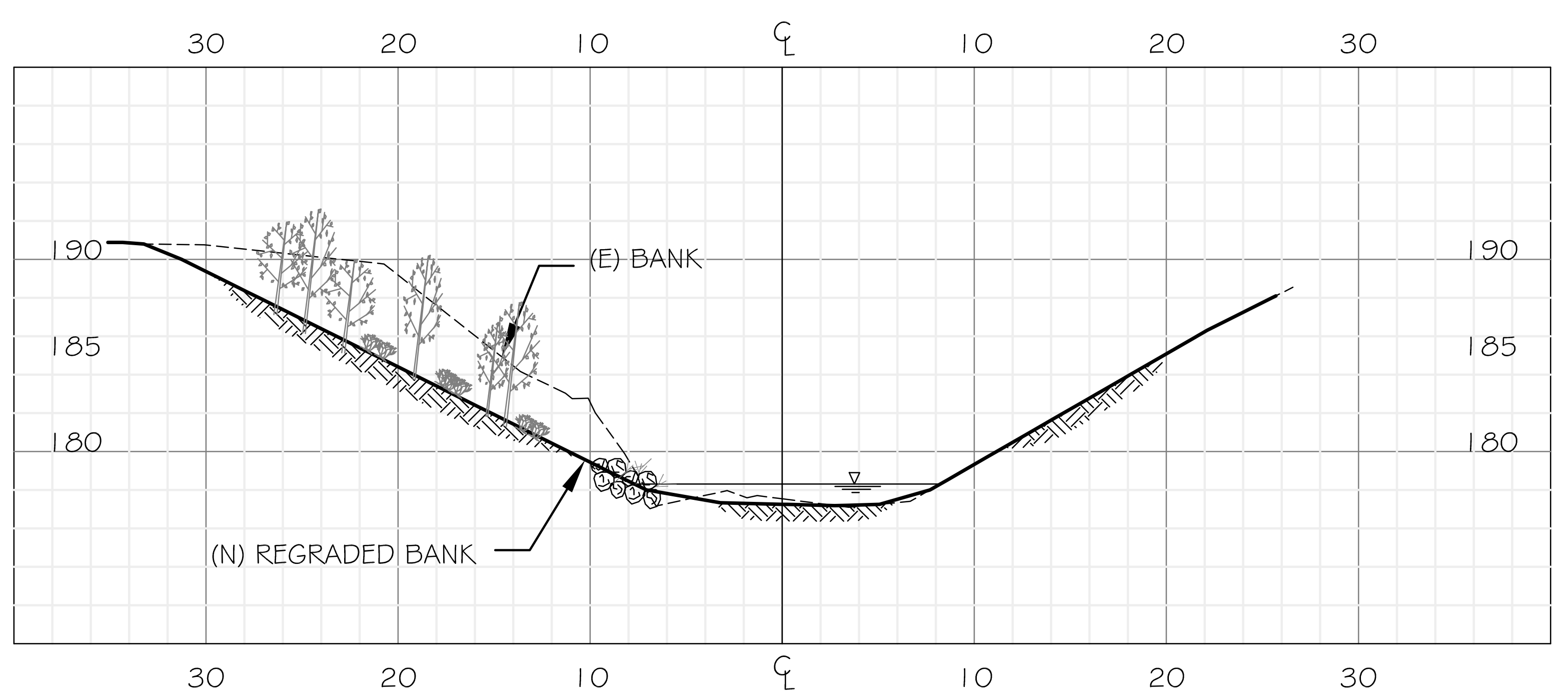



## PLAN VIEW

SCALE: 1"=20'




## SECTION A - A

SCALE: 1"=10'

PRELIMINARY GRADING VOLUMES:
CUT: 116 C.Y.
FILL: 0 C.Y.

FIGURE 7.5. SITE 2-CONCEPTUAL BANK STABILIZATION PROJECT

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## 7.3. Coward Creek Bank Stabilization Project

### 7.3.1. Project Setting

A section of Coward Creek that borders an agricultural property and Carlton Road has experienced substantial bank erosion. The location of the project area is shown in Figure 7.6. The south side of the stream is privately owned cropland used primarily for berry and row crops. The north side of the stream parallels Carlton Road and is also cropland.

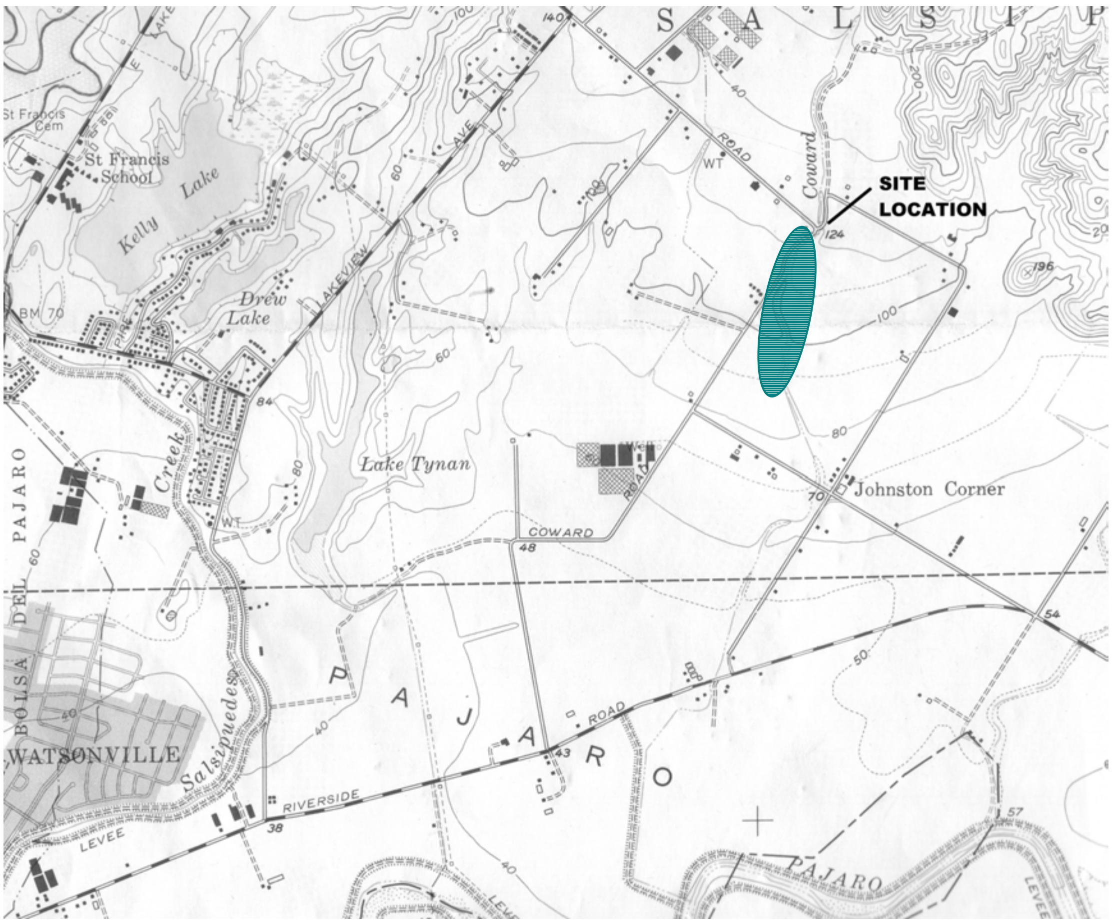



Figure 7.6 Site Vicinity of the Scurich Property

During the extreme El Nino storm events in 1998, flood stage flows caused substantial bank erosion and some incision of the channel resulting in vertical, unstable banks along approximately 850 feet of the stream. Figure 7.7 shows a section of stream bank adjacent to the croplands on the south side of the stream and Figure 7.8 shows a section of the bank adjacent to Carlton road. The bank erosion has damaged Carlton Road and caused the road to be one lane wide in this area. The adjacent properties have also lost land due to erosion.

Figure 7.7 Streambank Conditions on South Side of Coward Creek Channel

Figure 7.8 Carlton Road Side of Coward Creek

The stream bank in this entire reach is near vertical and slope failure continues to occur along the entire 850 feet of unprotected bank. The stream bank and bed material is composed mostly of silty sands and gravels and is highly erosive when it is exposed. Stream banks are near vertical. Since 1998, periodic high flow events have resulted in undercutting and bank failure in several sections of the stream. The stream is under going lateral erosion in this reach--the stream is widening rather than deepening. This is evident from the large number of mature trees established near the channel bed.

The County of Santa Cruz has proposed installing a concrete crib wall along approximately 80 feet of the channel to repair Carlton Road. Repairing the channel with a concrete crib wall will armour the bank in this section of the stream, which can deflect high flows to the opposite bank resulting in more erosion. In order to stabilize and restore the entire 850 foot long reach, several bank stabilization measures are proposed, which include:

1. Reshaping the channel banks (laying them back to 1:1 horizontal to vertical slope),
2. Installing a vegetated rip-rap along the toe of the bank,
3. Installing willow fascines along the slope of the new bank, and
4. Revegetating the entire bank with native riparian vegetation.

The following sections describe the proposed project in more detail and present a preliminary analysis of the project's implement and an engineering cost estimate.

7.3.2. <u>Conceptual Restoration Plan</u>

**Project Goals.** The overall goals of the conceptual restoration plans for this project site include providing long-term bank stabilization, reducing future erosion and sedimentation problems, and improving the riparian habitat in this section of the stream.

**The Site.** In order to restore the bank to a more stable condition, the proposed project will include removing debris along the bank and in the stream, regrading the streambank, installing vegetated rip-rap and bank stabilization measures, including live fascines and native vegetation. The slope will be regraded to at least a 1:1 slope (50%). The project will involve some rough and final grading. Preliminary grading estimates include 1,436 cubic yards of cut and 973 cubic yards of fill.

The toe of the banks will be protected from scour by installing vegetated rip-rap that will extend up the bank approximately three feet above the channel. Willow staking will be placed in between the riprap to provide long-term stability of the bank.

After installation of rip-rap, the newly graded streambank will have live willow fascines installed in lateral trenches installed across the face of the bank. The fascines are live structures that provide erosion control of unstable slopes. Because the combined use of vegetated rip-rap and fascines are live and inert materials, they are immediately effective. The effectiveness of the planted vegetation will increase with its advancing age and size. The fascines are buried in a shallow trench across the slope to half or three-quarters of its diameters. Approximate spacing for fascines will be 3-4 feet above the top of rip- rap and between each fascine row. The design will require three rows of fascines. The willow fascines can be constructed from cuttings of nearby willow groves formed into bundles, tapered at each end, 6-30 feet in length, depending on site conditions and limitations in handling. The completed bundles are typically 6-12 inches in diameter. The fascine rows are installed from the bottom to top, using soil from the trench above or fill above to compact and work into the fascines. Live willow stakes are generally used to staking the fascines into the bank. Stakes 2-3 feet in length are used to hold fascines in place, using standard practices for proper installation. The fascines are an integral element in the bank stabilization and will establish a living barrier to further erosion. Fascines are also not prone to scour damage.

The top of the bank will be vegetated with native, locally available plants. After the bank is reshaped, it is to be compacted (track-rolled) by driving a piece of equipment up and down the face of the slope, not across the slope. The top of the bank will be re-vegetated with a combination of seed and container stock. After the project has been constructed, the new vegetation will need to be irrigated during the dry season to assure the successful establishment of the plants. Irrigation can be provided either through overhead spray or though drip emitters placed at the base of the individual plants. An irrigation system will be installed during site re-vegetation and maintained until the plants are established.

A conceptual plan of this project, including the existing and regraded streambank topography is presented in Figure 7.9. Figure 7.10 shows a typical cross section, plan view and detail of the restored banks. Figure 7.11 presents the preliminary grading analysis and cut and fill volume estimates for the project. Although the streambank will be graded back away from the center line of the channel, the amount of land lost at the top of the stream is relatively small.

### 7.3.3. Project Analysis

#### DESIGN PLANS AND PERMITTING

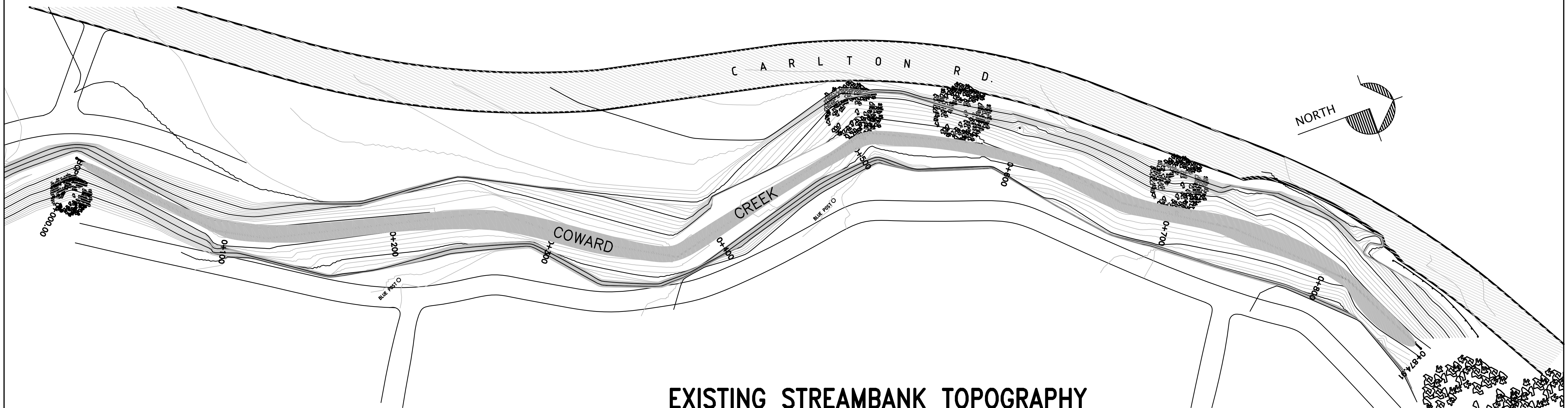
Once the project has received funding, detailed design plans, planning and permitting activities will be required.

Engineering Analysis and Design
Implementation of this project will require completion of an engineering analysis to evaluate the hydraulic and geotechnical conditions of the stream. The hydraulic analysis will be conducted to evaluate stream flow and conveyance under existing and restored conditions. A geotechnical analysis should be performed to evaluate soil conditions and provide specifications for final design and construction specifications. Based on the hydraulic and geotechnical analysis, detailed design plans and specifications can be prepared. The detailed design plans will include the following:

- A site plan showing the location and extent of the of the project;
- A grading plan showing the limit of grading, cut and fill volumes, and staging areas;
- A restoration plan showing the plans and details of the proposed improvements;
- A re-vegetation plan; and
- Construction specifications.

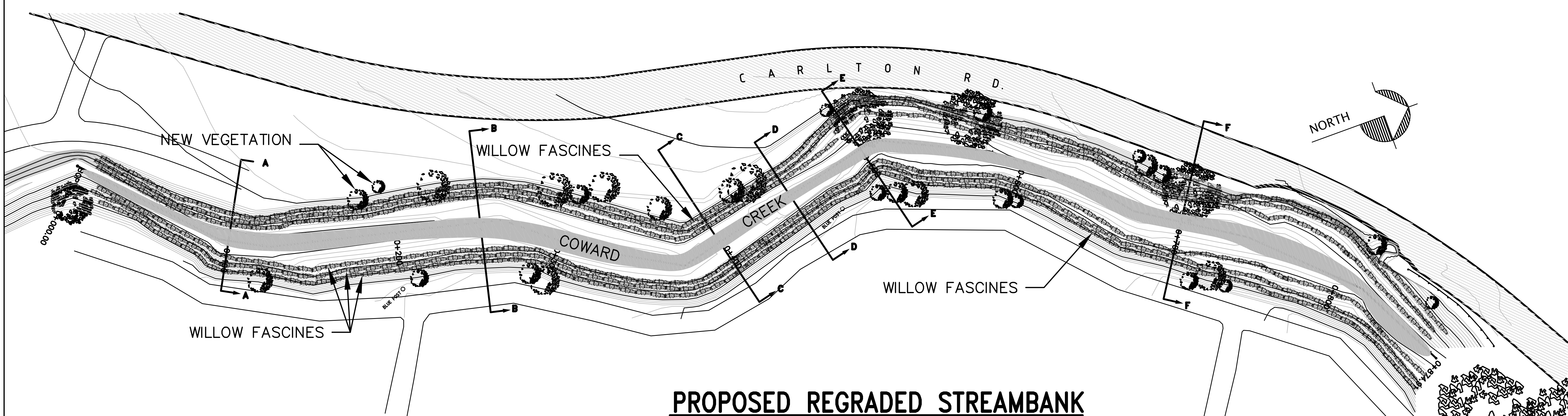
Biotic Survey
A qualified biologist will most likely be required to conducted surveys of the project site to document biological conditions for resource agencies that will require permits for the project.

#### PERMITTING & REVIEW
Because the project is located in a riparian corridor, several local, state and federal permits will be required to execute the project.




## EXISTING STREAMBANK TOPOGRAPHY

SCALE: 1" = 60'




## PROPOSED REGRADED STREAMBANK

SCALE: 1" = 60'

FIGURE 7.9. EXISTING AND PROPOSED SITE PLAN

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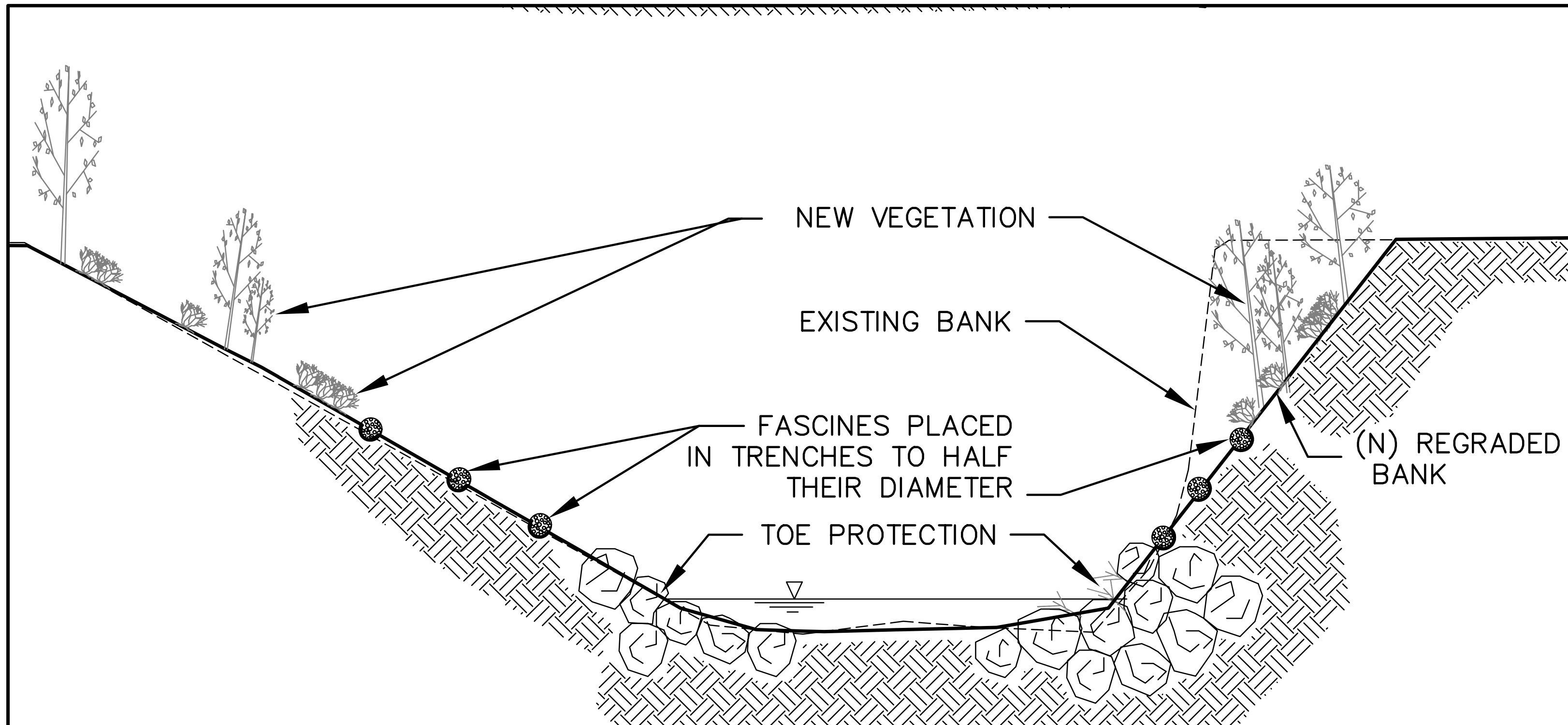
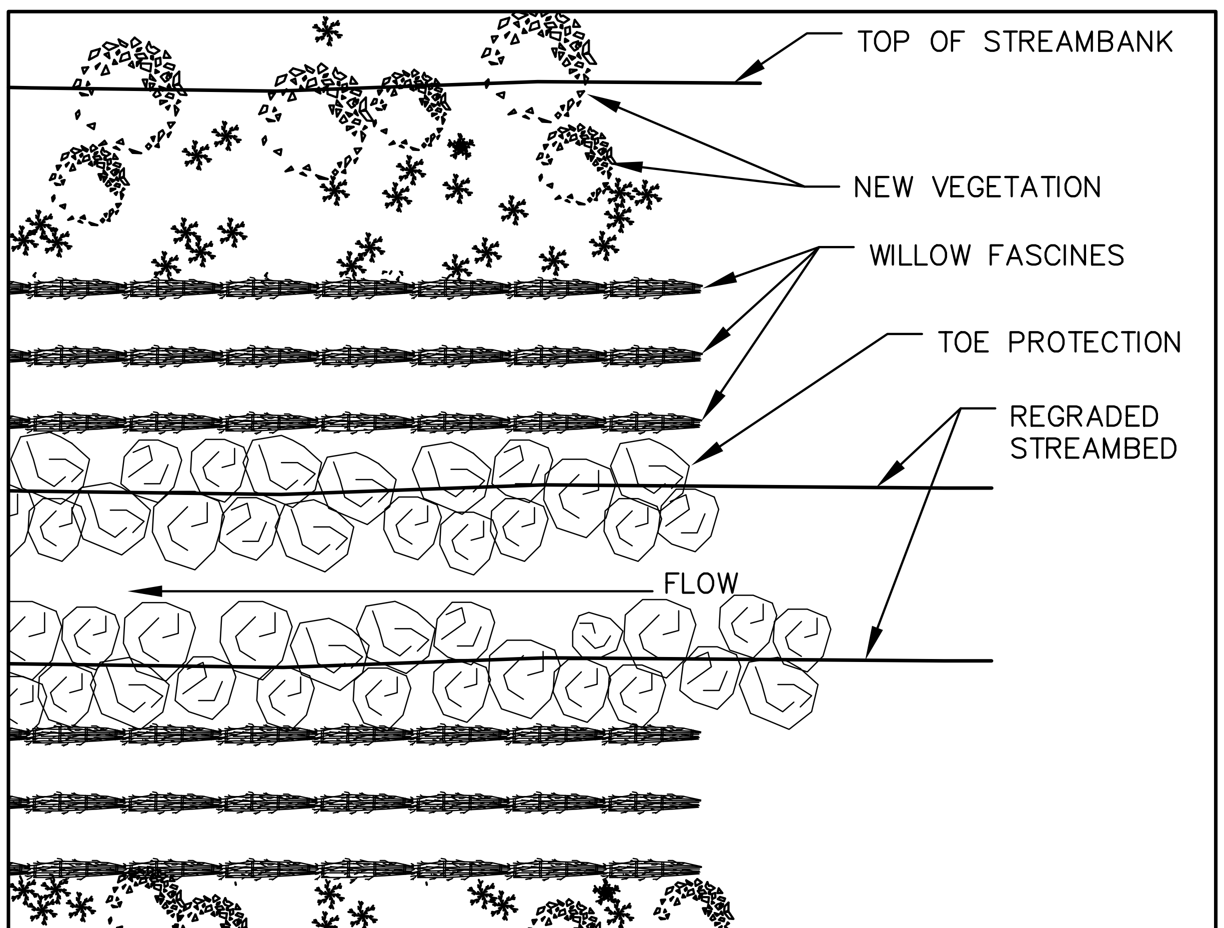
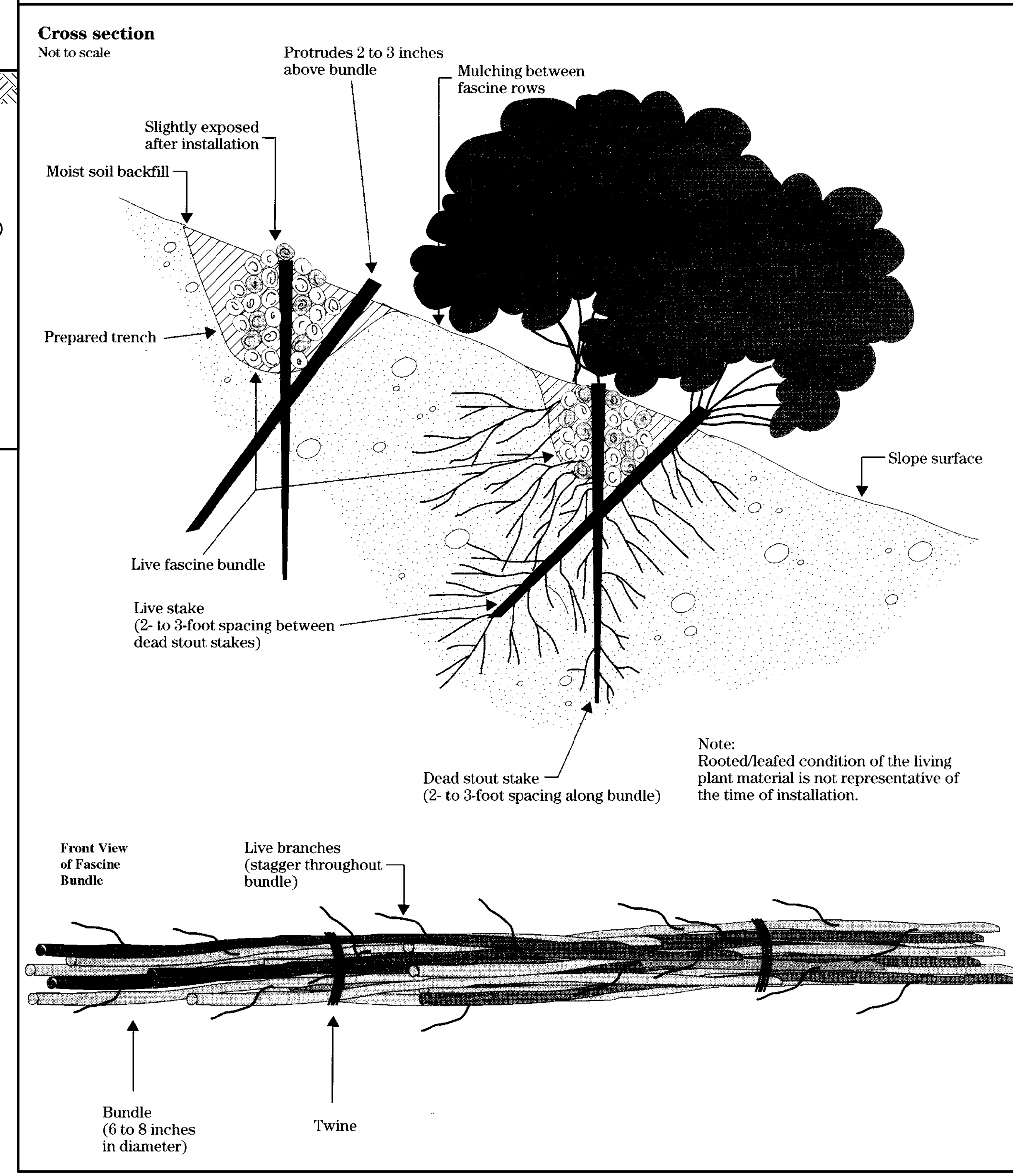



**TYPICAL CROSS SECTION**
SCALE: NTS




**TYPICAL PLAN VIEW**
SCALE: NTS




**TYPICAL FASCINE DETAIL**
SCALE: NTS

FIGURE 7.10. PROPOSED SCURICH PROPERTY STREAM BANK RESTORATION

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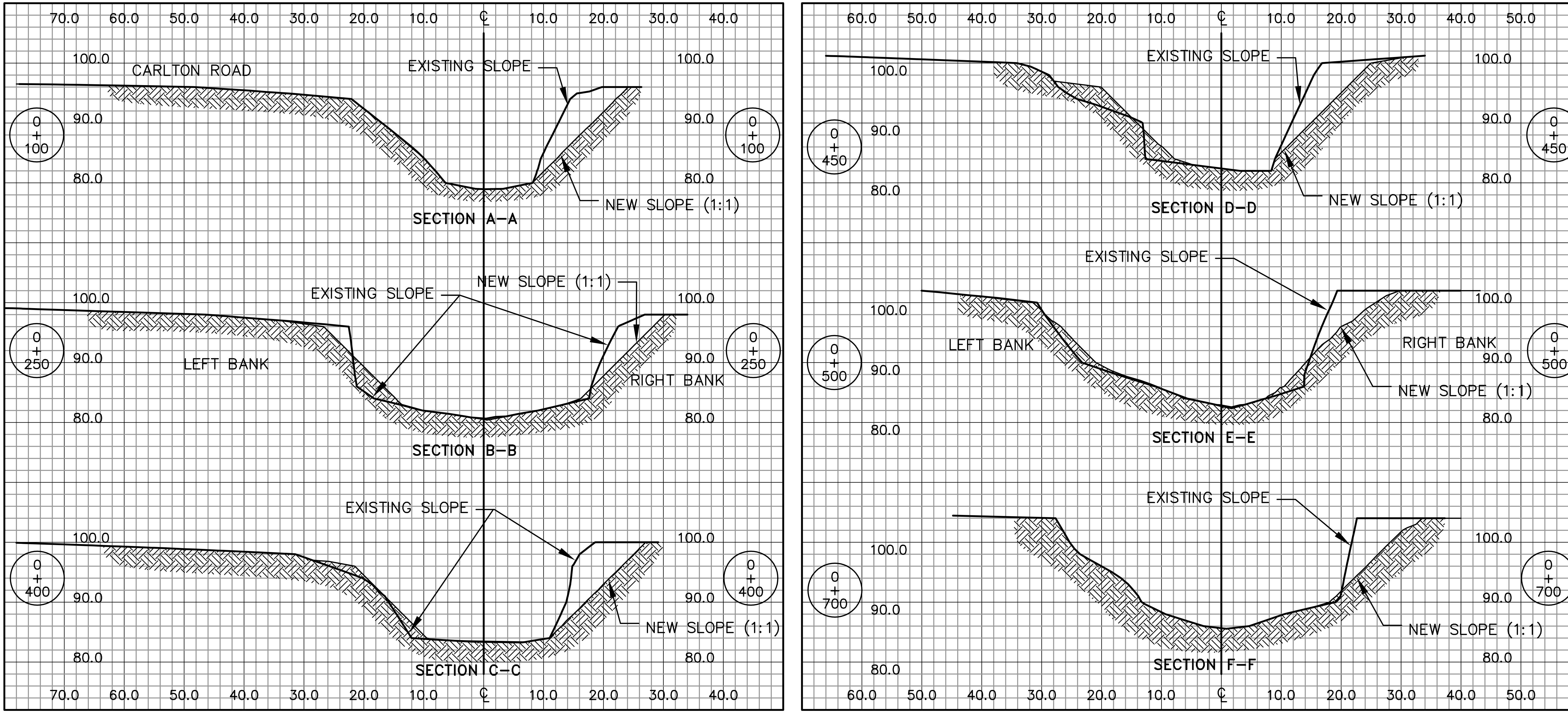


CUT AND FILL VOLUMES (80% COMPACTION FACTOR)

LEFT BANK:
CUT = 365 CY
FILL = 746 CY
RIGHT BANK:
CUT = 1071 CY
FILL = 227 CY
TOTAL:
CUT = 1436 CY
FILL = 973 CY

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FIGURE 7.11. CUT AND FILL VOLUMES

**Santa Cruz County.** The County of Santa Cruz will require that a grading permit and a riparian exception be obtained prior to their approval of the project.

**California Department of Fish and Game (CDFG).** A Streambed Alteration Agreement will be required. If the Santa Cruz County Resource Conservation District undertakes the project, then a 1601 permit would be required, and if the private landowner applies for a permit, a 1603 permit is required.

**US Corps of Engineers (USCOE).** A USCOE Section 404 permit is required to carryout work within jurisdictional "waters of the US".

**Regional Water Quality Control Board (RWQCB).** A Section 401 Certification from the Regional Water Quality Control Board (RWQCB) is required, which is part of the 404 permit process, but obtained directly from the RWQCB.

**Other Agencies.** Because the project will be conducted in a riparian corridor, the project may also be reviewed by other resource agencies, including the National Marine Fisheries Service and the US Fish and Wildlife Service.

#### 7.3.4. Project Implementation

Project implementation will involve the regrading of the site, installation of the vegetated rip-rap, willow fascines and revegetation of the site. The construction period of the project will most likely take between 4 to 6 weeks, depending on the final project design and on time restrictions imposed by the County of Santa Cruz and the California Department of Fish and Game.

#### 7.3.5. Project Monitoring and Maintenance

A pre- and post project monitoring and maintenance program will be required to evaluate the performance of the enhancement project. The project will involve structural improvements, including construction of bank stabilization and erosion control measures, and extensive site re-vegetation. All of which will require ongoing monitoring and periodic maintenance to achieve the long-term restoration benefits provided by the project.

Since the project will be constructed within a very dynamic hydrologic setting, the proposed structural improvements, erosion control and re-vegetation measures may experience damage, adjustments, and partial plant survival. A key element of the project will be to implement a long-term monitoring and maintenance program to evaluate the physical and biological condition of the project and to detect and correct situations requiring repair or modification.

The objectives of the monitoring and maintenance program are:

- Repair any minor damages quickly (i.e. erosion or gullies) to maintain the banks in a stable configuration and to avoid severe, more costly damage resulting from deferred maintenance.

- Assure the restoration project is operating in compliance with the regulation and guidelines of the California Department of Fish and Game (CDFG), the National Marine

Fisheries Service (NMFS), the California Regional Water Quality Control Board (RWQCB), and the County of Santa Cruz.

- Assess the effectiveness of the project.

7.3.6. Project Cost

The preliminary engineering cost estimate to implement the proposed project is presented in Table 7.2.

Table 7.2 Engineering Cost Estimate for Coward Creek Streambank Restoration Project

| Description | Unit | Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|
| **1. Design and Permitting** | | | | |
| 1.1. Engineering Analysis and Design | | | | |
| a. Hydraulic Analysis | | | | 4,000.00 |
| b. Geotechnical Analysis | | | | 4,000.00 |
| c. Engineering Design Plans and Specifications | | | | 10,000.00 |
| 1.2. Biotic Survey | | | | 4,000.00 |
| 1.3. Project Permitting (SCCRCD Staff) | | | | 5,000.00 |
| 1.4. Permit Fees | | | | 5,000.00 |
| **2. Project Implementation** | | | | |
| 2.1. Rough grading | CY | 2500 | 6.00 | 15,000.00 |
| 2.2. Install vegetated rip-rap toe protection | LF | 1700 | 25.00 | 42,500.00 |
| 2.3. Install fascines | LF | 5100 | 10.00 | 51,000.00 |
| 2.4. Interim erosion control measures | | | | 5,000.00 |
| 2.5. Re-vegetation | | | | 10,000.00 |
| **3. Project Monitoring and Maintenance** | | | | 5,000.00 |
| Total Project Sub-total = | | | | 160,500.00 |
| Contingency (10%) = | | | | 16,000.00 |
| **Total Project Cost =** | | | | 176,500.00 |

## 7.4. Upper College Lake Restoration Plan

7.4.1. Introduction

In 1994 the Pajaro Valley Water Management Agency (PVWMA) acquired an approximately 80 acre parcel of land in the upper end of College Lake, as shown in Figure 7.11. Historically the site was farmed, but severe storm events and flood stage flows in 1998 caused Casserly Creek to break through a manmade channel and re-enter the historical stream channel. Casserly Creek meanders through the property. This event resulted in a substantial amount of sediment being deposited in this area, and the cost to reclaim the agricultural use of the area has become financially prohibitive to the Agency. Currently, there are extensive groves of willow and several off-road vehicle trails established throughout the property. The site is used illegally by off road recreational vehicles, and the Agency's attempt to thwart this activity has not been successful to date.

The Agency is very interested in exploring alternative uses for approximately 50 acres of the property. The project presents a unique opportunity to restore a relatively large tract of open space as a multi-use facility that would restore wetland and riparian habitat, create environmental education and recreational opportunities, and provide local water supply. Presently, there are very few publicly accessible wetland and riparian parklands established in the Pajaro Valley that are within close proximity to the city of Watsonville, the major urban center in the County of Santa Cruz and Pajaro Valley. As the Pajaro Valley continues to become more urbanized, access to parklands will become more vital to the growing population. Alternative conceptual restoration plans have been developed for the site and each achieves different multi-use benefits considering the function of the project and potential site constraints.

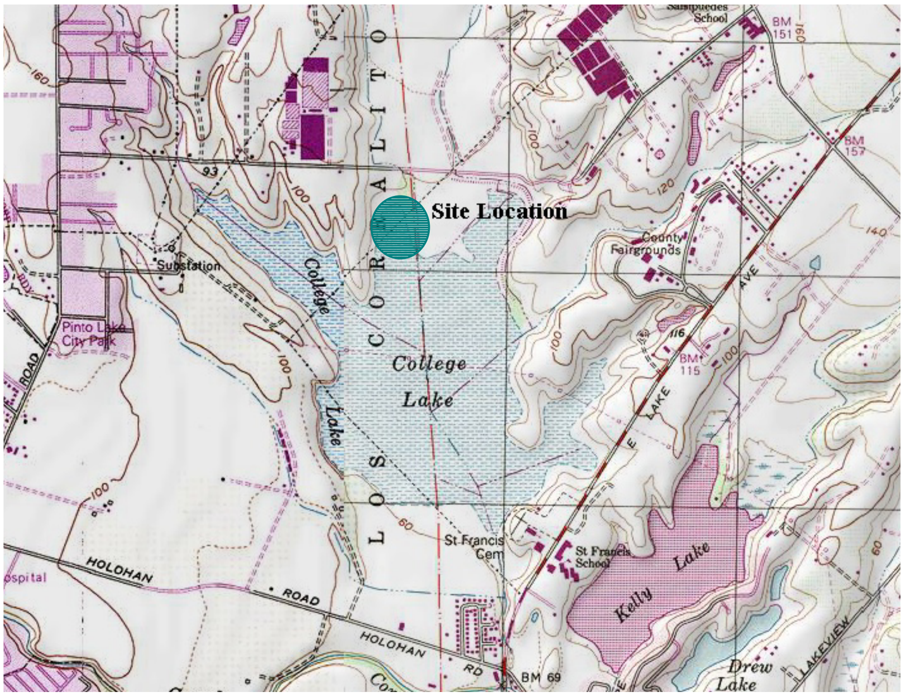


Figure 7.12 Site Location Map

7.4.2. Project Setting

The upper College Lake Restoration project is located at the north side of College Lake. College Lake is located approximately one mile north of the Watsonville city limits and is a naturally occurring seasonal lake that receives surface water inflow from the Green Valley, Casserly and Hughes creek watersheds. These streams drain approximately 11,000 acres of range, rural residential and croplands. Outflows from the lake naturally flow downstream to Salsipuedes Creek in the winter months. Downstream from College Lake, Corralitos Creek converges with Salsipuedes Creek, which flows into the Pajaro River and ultimately into the Monterey Bay.

An existing low dam on the south side of the lake causes inundation of approximately 260 acres of the basin. In the spring, the lake basin is typically pumped dry to allow farming to take place during the summer months. This practice continues today and a majority of the lakebed is used for row crops including vegetables, strawberries, flowers, raspberries, and grapes.

Both the PVWMA and the U.S. Corps of Engineers (USCOE) are evaluating College Lake for future water supply and flood control projects, respectively. The PVWMA is considering development of the "Expanded College Lake" facilities, which calls for increasing the reservoir elevation of the lake and increasing the area of inundation to 420 acres. Stored water would be treated and available as a local source of agricultural supply and possibly used for the Aquifer Storage and Recovery project (ASR). The ASR project would entail injecting treated surface water into the groundwater aquifer during the winter months and then extract that water during the summer agricultural season. The proposed project would involve constructing an earth embankment dam and installing a pumping plant, with pretreatment, filtration and disinfection treatment facilities. The USCOE project would also involve the construction of an earthen embankment to increase the flood storage capacity of College Lake. Both projects may potentially inundate the upper College Lake project area, and as such, may pose as a significant constraint on the long-term restoration of the area.

### 7.4.3. Surface Water Hydrology and Water Quality

College Lake is a seasonal water body that receives inflow from Green Valley, Casserly and Hughs Creeks. Green Valley and Casserly Creek are perennial streams, whereas, Hughs Creek is intermittent. Stream inflow into College Lake varies both seasonally and in response to storm events. To evaluate stream inflow conditions, a flow duration curve for surface water inflow to College Lake was developed using historical flow data extrapolated from Corralitos Creek provided by the PVWMA. A flow duration curve for College Lake inflow is presented in Figure 7.13, which presents the percentage of time average daily flow is equal to or exceeds a flow value. For example, the flow duration curve indicates that the average stream flow (occurring 50% of the time) into College lake is approximately 0.3 cubic feet per seconds (cfs) (~135 gallons per minute). Peak flow events can exceed 100 cfs, and during extreme flood stage events, flows can exceed 1,000 cfs. During the winter months, stream flows typically range from 5 to 20 cfs from December through March depending on the water year conditions (i.e. annual precipitation). From June through July, stream flow is typically less than 1.0 cfs and will continue to decline to less than 0.3 cfs in August and below 0.1 cfs in September. Actual flows will vary significantly depending on the previous and current water year conditions. Summer inflows to College Lake represent both base flow conditions and agricultural return flows.

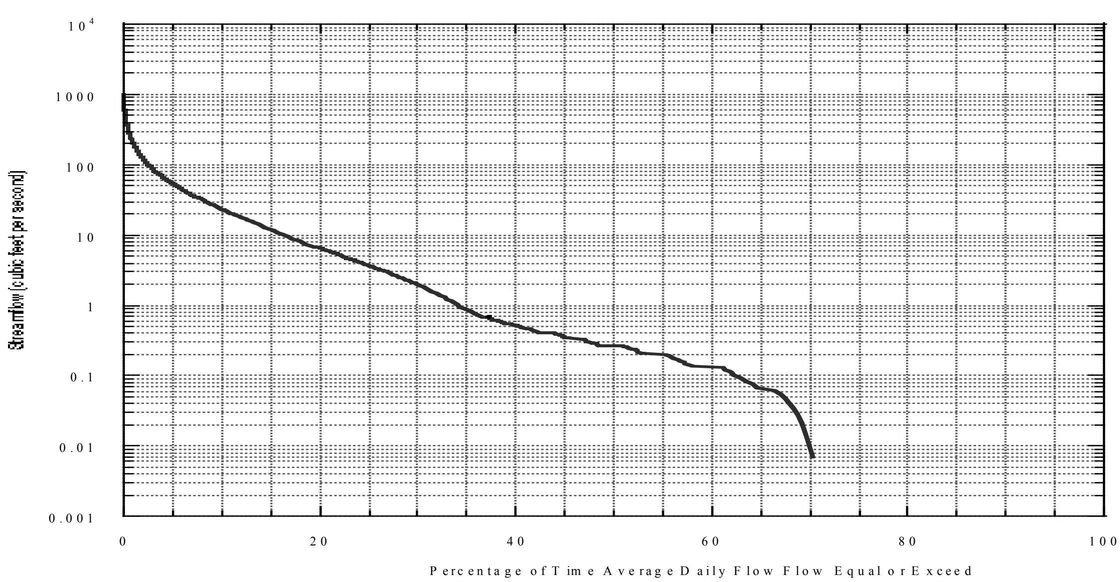


Figure 7.13 Flow Duration Curve for College Lake Surface Water Inflow

The PVWMA conducts routine water quality monitoring of the surface water inflow into College Lake. Table 7.3 summarizes water quality test results from 1994 through 2000. The results of the water quality tests indicate that the overall water quality is generally good. Turbidity and total suspended solids concentrations are elevated during both the winter and summer months. During the winter, months this is attributed to elevated levels of suspended fines and clays resulting from soils being wasted into the stream, whereas in the summer months algae in the water is the most likely source of elevated suspended solids and turbidity. Nitrate levels are generally elevated and occasionally exceed the drinking water standard, set at 45 mg/L. Total and fecal coliform bacteria are detected in relatively high numbers. These are attributed to a variety of sources including domestic animals, wildlife, and possibly failing septic systems in the upper watershed area.

Table 7.3 Summary of Water Quality Date for Surface Inflow to College Lake
(Source: PVWMA)

| | Physical Parameters | | | | | | General Minerals | | | | | | | | Nutrients | | | | Bacteria | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | pH | EC | TDS | Turbidity | TSS | TOC | Cl | Bicarbonate Alk | SO4 | Ca | Mg | K | Na | Boron | O-PO4 | NO3 | K-N | NH4-N | Total Coliform | Fecal |
| Units | pH | uhmos/cm | mg/l | NTU | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | MPN/100ml | MPN/100ml |
| 10/19/94 | 7.62 | 1010 | 646 | 48 | | | 61 | | 225 | 120 | 36 | 3.2 | 53 | 0.31 | | | | | | |
| 11/15/94 | 7.20 | 1040 | 750 | 62 | 60 | | 55 | 215 | | | | | | | <1 | 63.0 | | 0.5 | Present | Present |
| 12/08/94 | 7.40 | 1010 | 646 | 39 | | | 61 | | 32 | 30 | 11 | 4.4 | 19 | 0.11 | | | | | | |
| 01/21/95 | 6.70 | 305 | 200 | 175 | 26 | | 20 | 79 | | | | | | | 1.3 | 9.1 | 5.8 | | | |
| 02/18/95 | 7.55 | 382 | 244 | 57 | | | 25 | | 39 | 36 | 12 | 3.7 | 21 | nd | | 2.0 | | | | |
| 04/03/95 | 7.50 | 335 | 235 | | 120 | 9.8 | 16 | 93 | | | | | | | 0.7 | 10.0 | 3.0 | | >1100 | 43 |
| 12/18/95 | 7.55 | 700 | 455 | 140 | 36 | 4.4 | 40 | 145 | 115 | 68 | 30 | 3.4 | 35 | nd | <1 | 89.0 | 2.8 | | | |
| 01/16/96 | 7.99 | 391 | 250 | 90 | 162 | | 16 | | | | | | | | | 17.1 | | | | |
| 02/12/96 | 7.55 | 320 | 210 | 145 | 17 | 8.9 | 20 | 87 | 37 | 34 | 11 | 4.2 | 20 | 0.10 | <1 | 12.0 | 2.3 | | >1100 | 23 |
| 03/18/96 | 7.67 | 361 | 231 | 83 | 7 | | 21 | | | | | | | | | 9.9 | | | | |
| 04/22/96 | 8.25 | 510 | 330 | 41 | 45 | 6 | 29 | 155 | 65 | 58 | 18 | 3.8 | 30 | 0.14 | <1 | 10.0 | 8.7 | | >1100 | 4 |
| 05/24/96 | 8.16 | 574 | 367 | 125 | 117 | | 36 | | | | | | | | | 9.9 | | | | |
| 10/01/96 | 7.73 | 749 | 479 | 125 | 149 | | 37 | | 44 | 48 | | | | | | 37.4 | | | | |
| 11/21/96 | 7.30 | 380 | 245 | 1440 | 1050 | | 20 | 91 | 64 | 41 | | | | | 1 | 27.0 | 5.8 | | >1600 | >1600 |
| 03/20/97 | 7.40 | 450 | 300 | 38 | 29 | | 23 | 125 | | | 18 | 4.5 | 21 | <.1 | <1 | 4.2 | 3.1 | | >1100 | 75 |
| 04/22/97 | 7.84 | 578 | 370 | 96 | 88 | | 35 | | 125 | 90 | 16 | 3.2 | 28 | 0.12 | | 5.9 | | | | |
| 05/19/97 | 8.00 | 870 | 610 | 280 | 485 | | 47 | 225 | | | | | | | <1 | 61.0 | 0.6 | | >1100 | 140 |
| 06/17/97 | 7.62 | 899 | 575 | 835 | 2088 | | 46 | | 79 | 54 | 35 | 5.0 | 49 | 0.24 | | 90.0 | | | | |
| 12/03/97 | 7.25 | 520 | 340 | 70 | 34 | | 31 | 115 | | | | | | | 1.7 | 18.0 | 2.9 | | >1100 | 1100 |
| 01/12/98 | 7.53 | 347.2 | 224 | 237 | 139 | | 24 | | | | 17 | 6.8 | 27 | 0.16 | | 18.5 | | | | |
| 04/03/98 | 7.92 | 408 | 261 | 54 | 27 | | 21 | | 71 | 55 | | | | | | 29.0 | | | | |
| 05/08/98 | 8.51 | 483 | 309 | 37 | 27 | | 26 | | | | | | | | | 7.9 | | | | |
| 05/28/98 | 8.30 | 540 | 360 | 49 | 41 | | 29 | 175 | | | | | | | <1 | 3.2 | 6.3 | | >1100 | 4 |
| 07/01/98 | 7.61 | 807 | 516 | 136 | 158 | | 43 | | | | 17 | 3.6 | 33 | 0.14 | | 32.1 | | | | |
| 01/19/99 | 7.50 | 155 | 110 | 320 | | | 8 | | | | | | | | | 4.2 | | | >1600 | >1600 |
| 02/01/99 | 7.52 | 327 | 209 | 134 | | | 20 | | | | | | | | | 12.3 | | | | |
| 03/02/99 | 7.77 | 341 | 218 | 65 | | | 18 | | | | | | | | | 7.5 | | | | |
| 11/24/99 | 7.53 | 567 | 363 | 43 | | | 33 | | | | | | | | | 9.6 | | | | |
| 01/25/00 | 7.29 | 381 | 244 | 42 | | | 20 | | | | | | | | | 8.1 | | | | |
| 02/24/00 | 7.41 | 271 | 173 | 244 | | | 14 | | | | | | | | | 1.8 | | | | |
| 03/14/00 | 7.83 | 323 | 207 | 41 | | | 17 | | | | | | | | | 2.2 | | | | |
| 03/23/00 | 8.27 | 376 | 241 | 8.1 | | | 19 | | | | | | | | | 1.2 | | | | |
| 04/18/00 | 7.96 | 581 | 372 | 45 | | | 31 | | | | | | | | | 2.3 | | | | |
| **MCL** | | | | | | | | | | | | | | | | ***45*** | | | | |

### 7.4.4. Alternative Conceptual Restoration Projects

**Overview of Enhancement Opportunities**

Conceptual restoration plans have been developed for the area with the intent of:

1. Develop a series of potential projects that can achieve an array of environmental and social benefits to the area; and

2. Provide a preliminary planning tool to direct future long-term planning and development activities for the area.

By restoring wetlands and riparian habitat at the site with other amenities, such as a trail system and water storage facilities, several different enhancement opportunities can be achieved, including:

- Improving water quality
- Flood flow attenuation
- Wildlife habitat enhancement
- Restoration of historical wetlands and riparian habitat
- Creation of aesthetic and recreation areas
- Research and environmental education
- Water storage and supply

**Water Quality Enhancement**. As previously described surface water quality entering College Lake has elevated concentrations of nitrogen, suspended solids, pathogenic bacteria and other potential pollutants, such as soluble pesticides. A properly designed enhancement wetland system can provide a high level of water quality treatment to remove nitrogen, sediment and associated toxicants, soluble pesticides and pathogenic bacteria. The use of wetlands for treatment can significantly lower the cost of water treatment because the systems rely on plant and animal growth instead of the addition of power or chemicals. Also, the plant communities present in the wetlands naturally adjust to changing water levels and water quality conditions.

**Flood Flow Attenuation.** Floodflow attenuation is the process by which peak flows from runoff, surface flow, and precipitation are stored and delayed. Wetlands can act to detain flood waters by intercepting sheet flow and flood waters. By lowering the flood peaks either through storage or desynchronization, wetlands act to decrease flood related damage. Flood hazard exists on Salsipuede Creek and lower Pajaro River.

**Wildlife Habitat Enhancement.** Restored wetland and riparian habitats will support a diverse aquatic and upland wildlife. Wetland ponds and the stream will also support a variety of fish and invertebrate populations and habitat for numerous species of birds, mammals, reptiles, and amphibians.

**Restoration of Historical Wetlands and Riparian Habitat.** Prior to the mid 1800's, wetland and riparian habitat was abundant throughout the Pajaro Valley. However, urbanization and reclamation of agricultural lands has significantly reduced the amount of wetland and riparian habitat in the Valley. Enhancement projects that result to increase the total amount of wetlands and riparian habitat is beneficial to both wildlife and cultural values in the Pajaro Valley. A restored wetland/riparian facility will also play in an important role in protecting the Pajaro River and the Monterey Bay Sanctuary.

**Aesthetic and Recreation Areas.** Integrating a system of trails, elevated board walks and interpretive signs or elements into the restoration plan will provide the community with an area for passive and non-consumptive forms of recreation. The design of observation trails would allow visitors to experience the diverse wildlife and vegetation at the site and see how the project operates. Removal of ORV's must also be a priority.

**Research and Environmental Education.** A major benefit for creating a wetland system in close proximity to the City of Watsonville will be the opportunity for local schools to have a living laboratory to study environmental and biological sciences. Wetlands curriculum can be used to allow primary and secondary grade students to conduct yearlong projects focused on physical, biological, and hydrologic sciences. Local universities and colleges would have a facility to conduct a wide array of research on a variety of topics, including water quality, hydrology, wildlife biology, ecology, and other topics.

**Water Storage and Supply.** To offset groundwater over draft problems, alternative water supply projects are needed in the Pajaro Valley. A multi-use project could be developed to incorporate surface water storage and supply facilities in order to provide local growers in College Lake with an alternative source of water and/or be feed into the local agricultural supply system and/or as a source of water to the Aquifer Storage and Recovery project. Based on a cursory review of the flow data, it indicates that approximately 200 to 250 acre-feet of water could be supplied from a multi-use wetland/water storage facility during the summer growing season (June through September). Substantially more water would be available during the winter months, however, the exact amount would be dependent on the rainfall year.

### Conceptual Restoration Plans

Four alternative conceptual restoration plans have been developed. Each alternative achieves different functions or enhancement opportunities that reflect future uses and potential site constraints. All four alternatives include a forebay/sedimentation basin at the upstream end of the project. The forebay is used to trap sediment before it enters the downstream wetland and/or stream and as a way to route water to the stream and wetland(s) system.

### ALTERNATIVE 1 – MULTI-USE WETLAND/RIPARIAN/WATER SUPPLY FACILITY

This first scenario presents an extensive wetland and stream restoration plan, as shown in Figure 7.14, which includes:

1. A forebay for sedimentation and outlet control structures to direct flow to the restored stream and wetland system.

2. A stream restoration component that includes restoring approximately 2,000 lineal feet of Casserly Creek by modifying the geomorphology of the stream channel to a more stable configuration and stabilizing the bank, floodway, and upland areas with native riparian plantings.

3. Approximately 40 acres of a multi-cell wetland complex would be installed that would be designed to treat the surface water for reduction of nitrogen, soluble pollutants, and pathogenic bacteria.

4. Treated surface water from the wetland cells would be directed to a water storage reservoir for direct reuse on agricultural land or for further treatment and injected into the groundwater as part of the Aquifer Storage and Recovery project.

5. The wetland complex would include several miles of trails, viewing areas for passive recreation and environmental education purposes.

6. The wetland complex would provide sufficient storage capacity to provide substantial flood control benefits to the area, until the entire lake basin is inundated.

7. The proposed project may result in a net increase in the amount of wetlands restored at the property. This net increase could potentially be used by the PVWMA as off-site mitigation of future water supply projects carried out in another location in the Pajaro Valley region.

If the PVWMA or USCOE moves forward with either the "Expanded College Lake" facilities or a large scale flood control project, the restored wetland would become inundated in this scenario.

Table 7.4 presents a summary of the enhancement opportunities achieved for the conceptual plan.

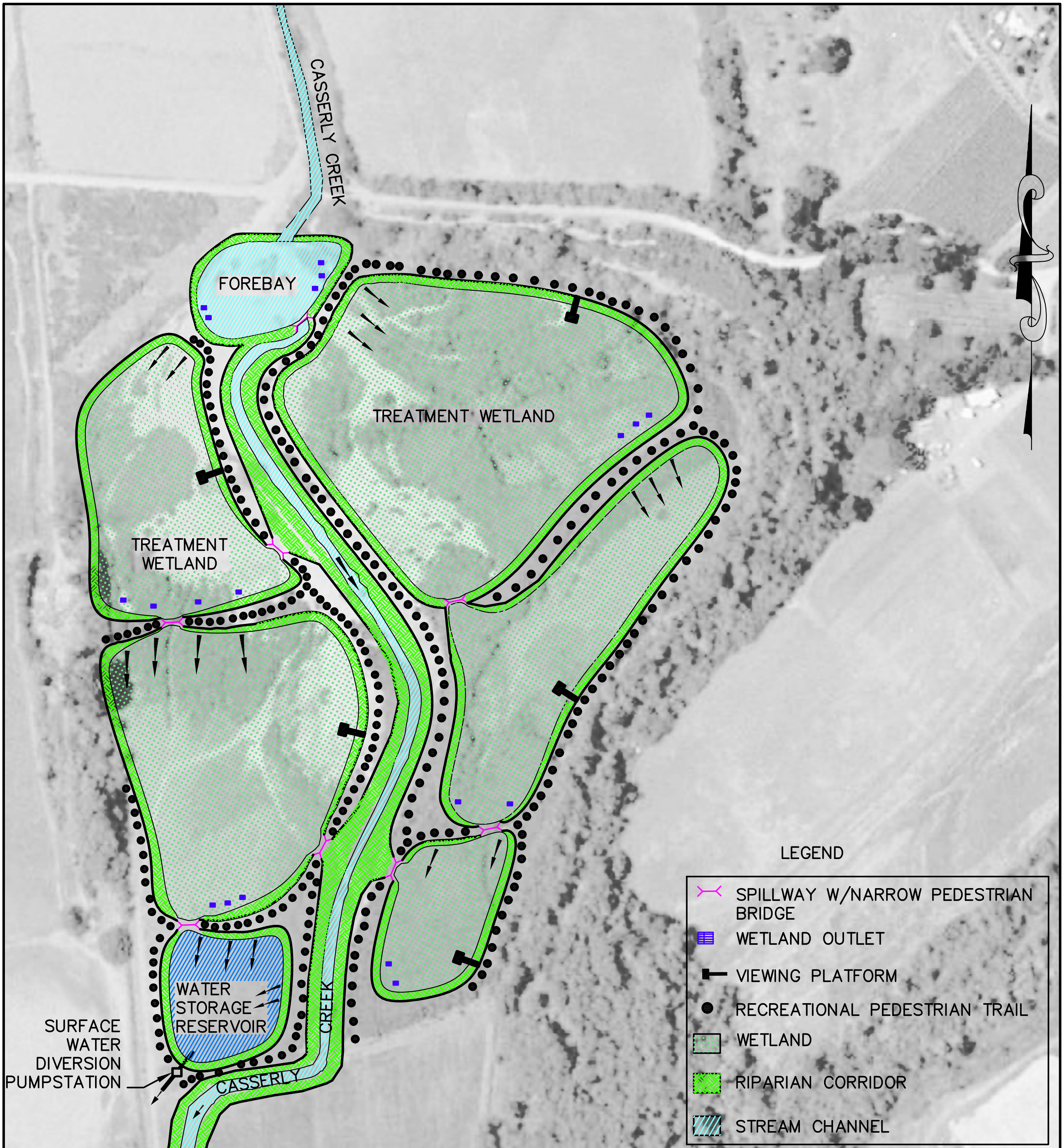


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FIGURE 7.14. MULTI-USE WETLAND/ RIPARIAN/ WATER SUPPLY FACILITY

**ALTERNATIVE 2 – WETLAND/STREAM RESTORATION FOR MITIGATION OF OTHER PVWMA PROJECTS**

This second scenario presents a smaller wetland and stream restoration plan, as shown in Figure 7.15, which would potentially provide off-site mitigation credit for future water supply projects undertaken by the PVWMA at a different location. The project includes the following elements:

1. A forebay for sedimentation and outlet control structures to direct flow to the restored stream and wetland system.

2. A stream restoration component that includes restoring approximately 2,000 lineal feet of Casserly Creek by modifying the geomorphology of the stream channel to a more stable configuration and stabilizing the bank, floodway, and upland areas with native riparian plantings.

3. Approximately 18 acres of mitigation wetlands that would be surrounded on the lakeside by a levee system, so that if the PVWMA and/or USCOE proceeded with the large water supply or flood control projects, the mitigation wetland would not be inundated and or impacted by these projects.

4. The stream and wetland system would include approximately one mile of trails, and viewing areas for passive recreation and environmental education purposes.

5. The wetland complex would provide some flood control storage benefits to the area.

Table 7.4 presents a summary of the enhancement opportunities achieved for this alternative conceptual plan.

**ALTERNATIVE 3 – WETLAND AND RIPARIAN HABITAT RESTORATION**

The third alternative presents a wetland and riparian restoration project that is designed to maximize the wildlife habitat enhancement. Under this scenario the wetland and stream systems cover the enter site, as shown in Figure 7.16. The conceptual design includes:

1. Installing a forebay for sedimentation and outlet control structures to direct flow to the restored stream and wetland system.

2. A stream restoration component that includes restoring approximately 2,000 lineal feet of Casserly Creek by modifying the geomorphology of the stream channel to a more stable configuration and stabilizing the bank, floodway, and upland areas with native riparian plantings.

3. Approximately 45 acres of wetland habitat that would be designed to maximize wildlife and riparian habit.

4. The wetland complex would provide sufficient storage capacity to provide substantial flood control benefits to the area until the entire lake basin is inundated.

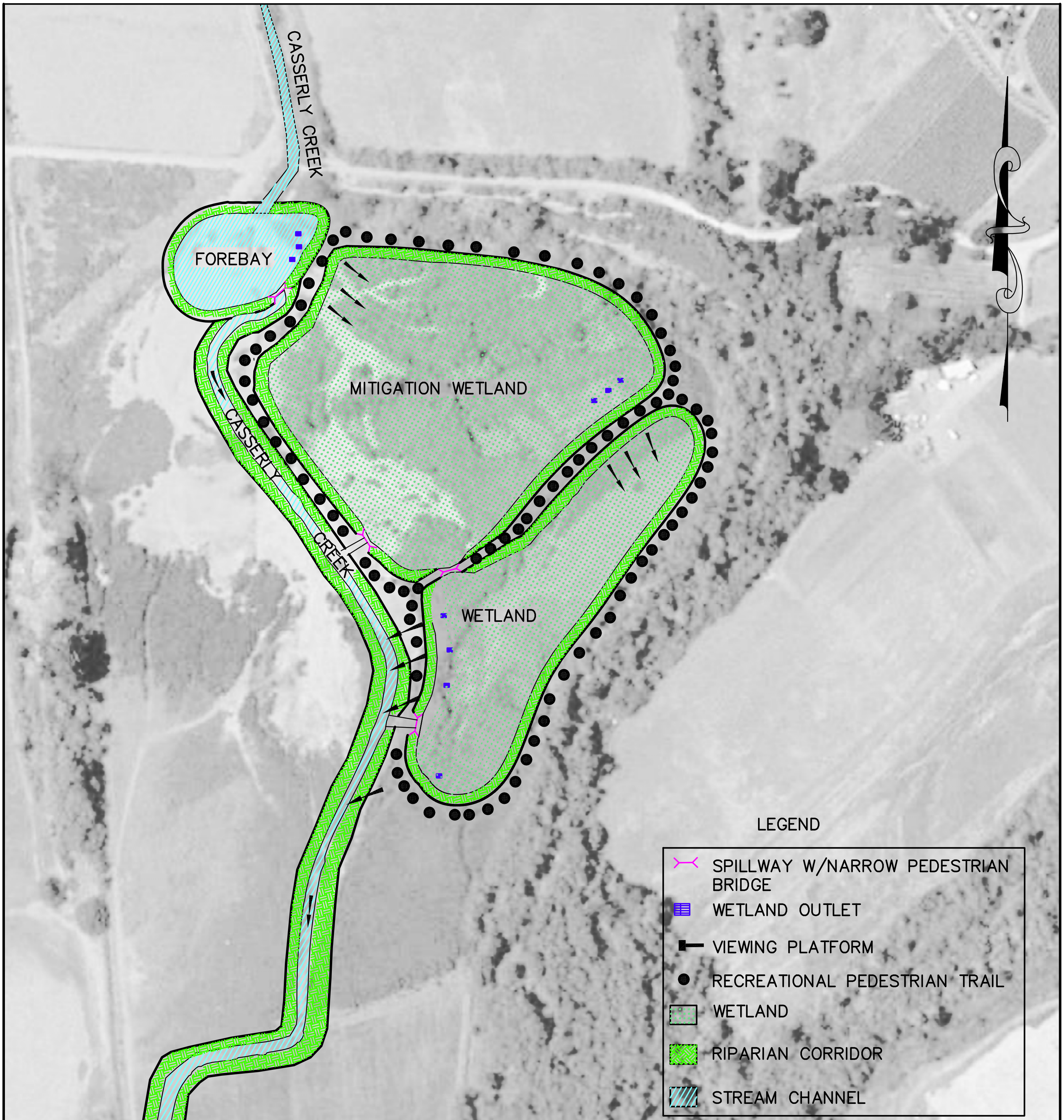


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FIGURE 7.15. WETLAND/ STREAM RESTORATION FOR MITIGATION OF OTHER PVWMA PROJECTS

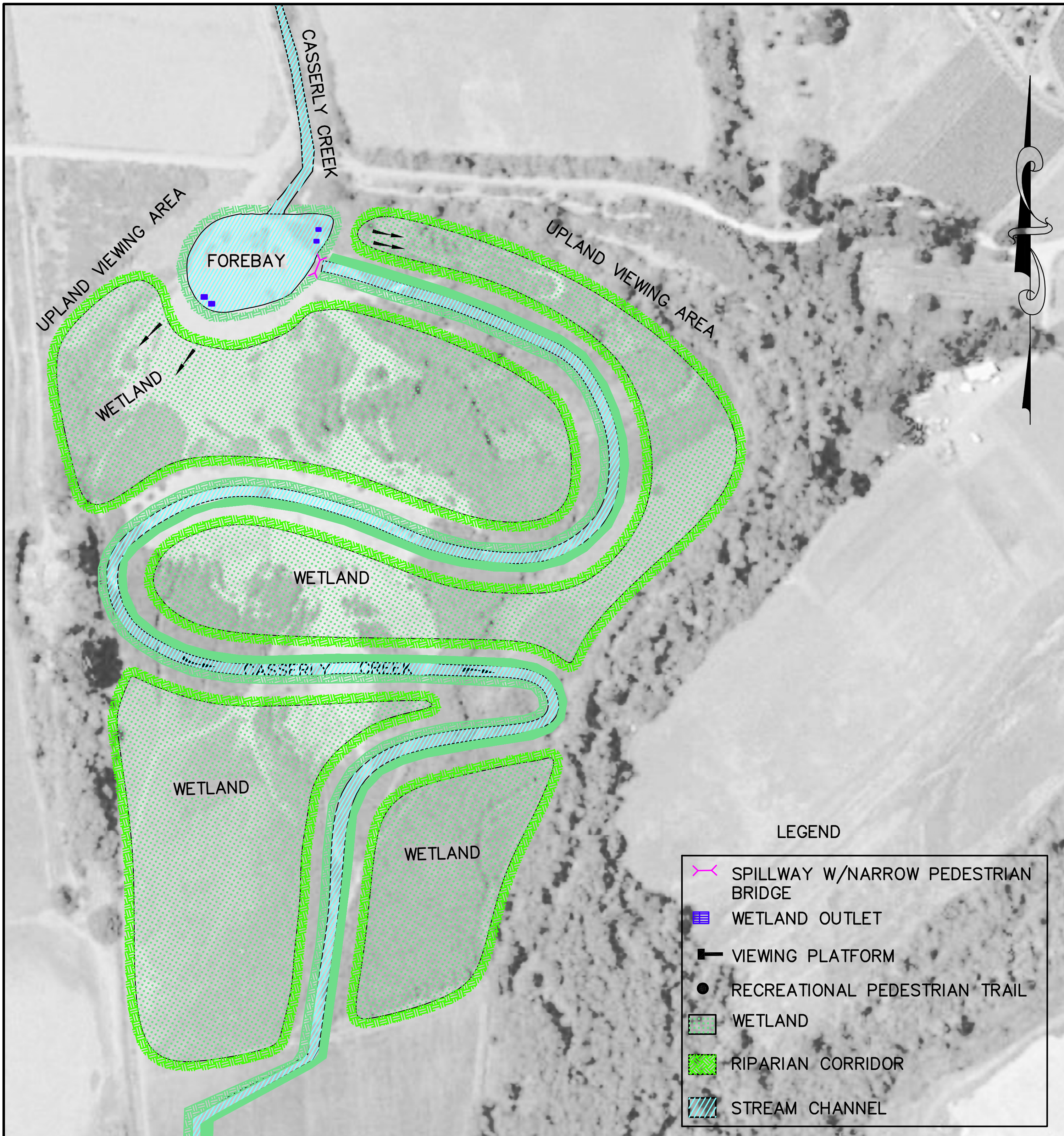


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FIGURE 7.16. WETLAND AND RIPARIAN HABITAT RESTORATION

5. The proposed project may result in a net increase in the amount of wetlands restored at the property. This net increase could potentially be used by the PVWMA as off-site mitigation of future water supply projects carried out in another location in the Pajaro Valley region.

If the PVWMA or USCOE moves forward with either the "Expanded College Lake" facilities or a large scale flood control project, the restored wetland would become inundated in this scenario.

Table 7.4 presents a summary of the enhancement opportunities achieved for the conceptual plan.

**ALTERNATIVE 4 – WETLAND HABITAT RESTORATION**

The final alternative presents an approximately 45-acre wetland restoration project that is designed to maximize the amount of wetland wildlife habitat enhancement. Under this scenario, the wetland system covers the enter site, as shown in Figure 7.17. The conceptual design includes:

1. Installing a forebay for sedimentation and outlet control structures to direct flow to the restored wetland system.

2. Restoring approximately 45 acres of wetland habitat that would be designed to maximize wildlife and riparian habit.

3. The wetland complex would include several miles of trails and viewing areas for passive recreation and environmental education purposes.

4. The wetland complex would flood flow storage capacity to reduce peak flood events until the entire lake basin and project area is inundated.

5. The proposed project may result in a net increase in the amount of wetlands restored at the property and provide for off-site mitigation of future water supply projects carried out by the PVWMA.

If the PVWMA or USCOE moves forward with either the "Expanded College Lake" facilities or a large scale flood control project, the restored wetland would become inundated in this scenario.

Table 7.4 presents a summary of the enhancement opportunities achieved for the conceptual plan.

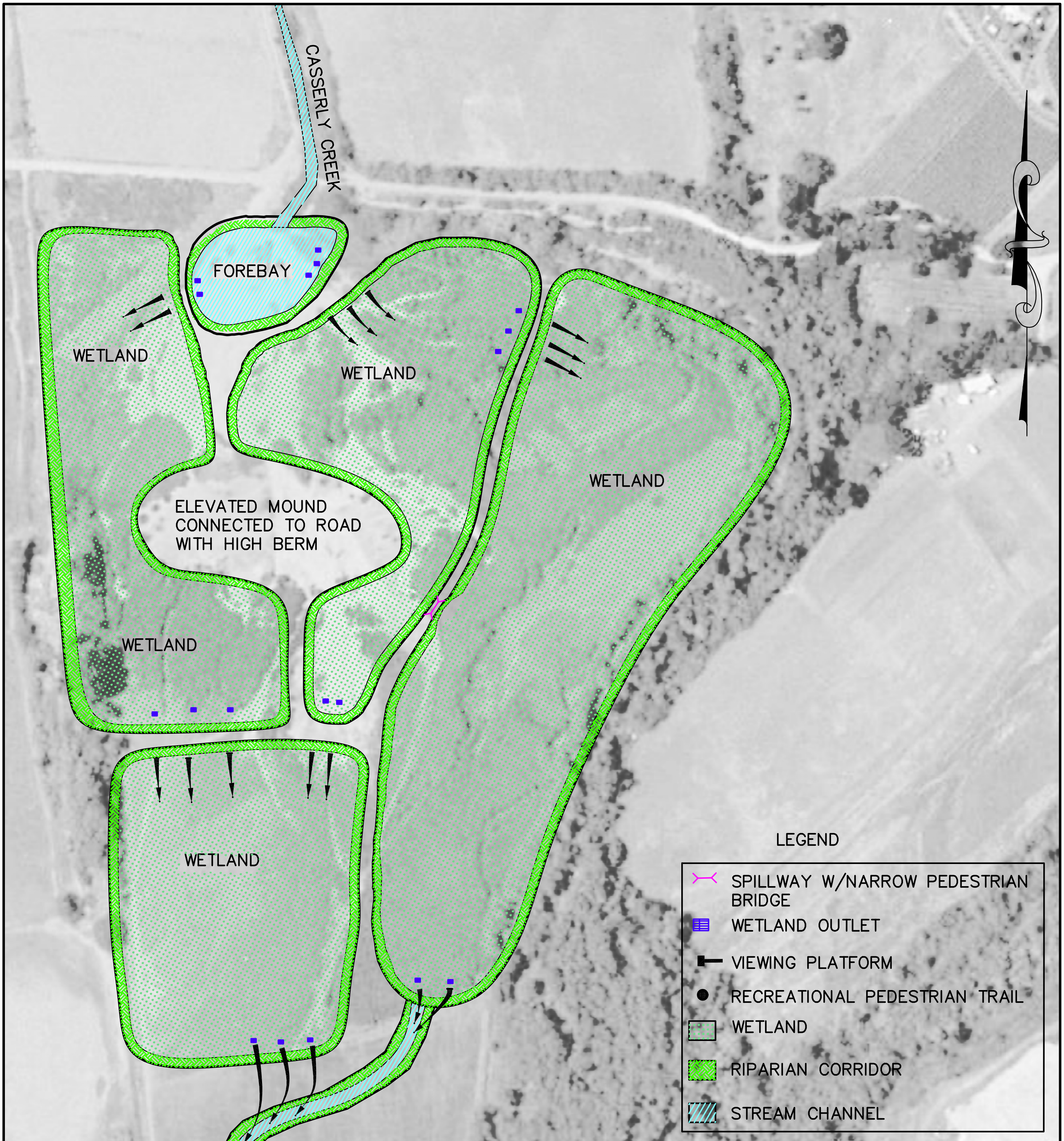


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FIGURE 7.17. WETLAND RESTORATION

Table 7.4 Summary of Enhancement Opportunities Achieved for Each Project Alternative

| | Project Alternative | | | |
|---|---|---|---|---|
| Enhancement Opportunities | Alternative 1: Multi-Use Wetland/Riparian/Water Supply Facility | Alternative 2 - Wetland/Stream Mitigation Project | Alternative 3 - Wetland and Riparian Habitat Restoration | Alternative 4: Wetland Habitat Restoration |
| Water Quality Enhancement | High | Moderate | High | High |
| Flood Flow Attenuation | High | Moderate | High | High |
| Wildlife Habitat Enhancement | High | Moderate | High | High |
| Restoration of Historical Wetlands and Riparian Habitat | High | High | High | High |
| Recreation | High | Moderate | Low | Moderate |
| Research and Environmental Education | High | Moderate | Moderate | Moderate |
| Water Storage and Supply | High | Low | Low | Low |

Legend: ○ -Low ◐ -Moderate ● -High

## 7.4.5. Project Analysis

### Planning and Feasibility Analysis

In order to undertake a comprehensive restoration project on this property, it will require a more detailed analysis of project and biological constraints. Recognizing that the project is located in an area that may be inundated by future water supply and/or flood control projects presents a significant constraint on the long-term restoration potential of the site. Presence of sensitive species may also limit the design and construction of the project. Finally, a more detailed economic analysis will be needed to assess the benefits/costs and to secure funds required to implement the project.

The PVWMA may also sell the property in near future. If the PVWMA chooses to sell the property they should be encouraged by public and private organizations to sell the property to an entity that is likely to implement one of the recommended alternatives.

As initial tasks, a planning and feasibility study should be conducted that includes a thorough analysis of project constraints related to:

- Environmental (Biotic and Cultural) resources;
- Future projects;
- Project costs and funding;
- Permitting;
- Engineering/design; and
- Long-term management.

**Engineering Studies and Design Plans**

If the project is determined to be feasible and funding is secured than the next phase of the project would entail development of engineering studies and preparation of detailed design plans and permitting activities will be required.

Engineering and Restoration Analysis
To implement this project will require completion of several engineering studies including: developing a detailed topographic map of the site, a hydrologic study, a geotechnical study of the soil conditions, and development of a site restoration and re-vegetation plan. The hydrologic study will be conducted and will include development of a water balance for the proposed project, and a hydraulic analysis to evaluate flow routing and hydraulic conditions through the facility under existing and restored conditions. A geotechnical study should be performed to evaluate soil and shallow groundwater conditions in order to develop specifications for final design and construction specifications. A site restoration plan should be developed by a multi-disciplinary team, including a biologist, hydrologist, landscape architect, engineer and restoration ecologist to determine design elements required to support terrestrial and aquatic wildlife, recreation and environmental education, and habitat improvements to the site.

Engineering Design Plans and Construction Documents
Based on the hydrologic, geotechnical and restoration plans, detailed engineering design plans and construction documents can be prepared.

**Permitting & Review**

Because the project is located in a riparian corridor, several local, state and federal permits will be required to execute the project. Given the magnitude and location of the project, the permitting process for the project may easily range from 12 to 24 months.

**Santa Cruz County.** The County of Santa Cruz will require that a grading permit and a riparian exception be obtained prior to their approval of the project.

**California Department of Fish and Game (CDFG).** A Streambed Alteration Agreement will be required. If the Santa Cruz County Resource Conservation District undertakes the project then a 1601 permit would be required, and if the private landowner applies for a permit a, 1603 permit is required.

**US Corps of Engineers (USCOE).** A USCOE Section 404 permit is required to carryout work within jurisdictional “waters of the US”.

**Regional Water Quality Control Board.** A Section 401 Certification from the Regional Water Quality Control Board (RWQCB) is required, which is part of the 404 permit process, but obtained directly from the RWQCB.

**Other Agencies.** Because the project will be conducted in a riparian corridor with possible endangered species habitat issues, the project may also be reviewed by other resource agencies, including the National Marine Fisheries Service and the US Fish and Wildlife Service.

#### 7.4.6. Project Implementation

Project implementation will involve the construction and operation of the facility. The construction period of the project will most likely take between 6 to 9 months, depending on the final project design and on time restrictions imposed by the County of Santa Cruz and the California Department of Fish and Game.

#### 7.4.7. Project Monitoring and Maintenance

A pre- and post project monitoring and maintenance program will be required to evaluate the performance of the enhancement project. The project will involve structural improvements, including construction of berms, bank stabilization and erosion control measures, and extensive site re-vegetation. All of which will require ongoing monitoring and periodic maintenance to achieve the long-term restoration benefits provided by the project.

Since the project will be constructed within a very dynamic hydrologic setting, the proposed structural improvements, erosion control and re-vegetation measures may experience damage, adjustments, and partial plant survival. A key element of the project will be to implement a short and long-term monitoring and maintenance programs to evaluate the physical and biological condition of the project and to detect and correct situations requiring repair or modification.

The objectives of the monitoring and maintenance program are:

- Assure the restoration project is operating in compliance with the regulation and guidelines of the California Department of Fish and Game (CDFG), the National Marine Fisheries Service (NMFS), the California Regional Water Quality Control Board (RWQCB), and the County of Santa Cruz.
- Assure the project and structures are operating as planned.
- Assess the effectiveness of the project.

#### 7.4.8. Project Cost

Preliminary cost estimates have been prepared for each element of the project. Table 7.5 presents the cost estimates for each of the primary and sub-tasks identified and described above for each alternative project. Table 7.6 presents a summary of the total costs for each primary task and the total estimated cost for implementing each alternative project.

## Table 7.5 Preliminary Cost Estimates for Upper College Lake Restoration Planning and Implementation

| Description | Unit | Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|
| **1. Planning and Feasibility Analysis** | | | | |
| 1.1. Environmental Review | | | | 35,000.00 |
| 1.2. Evaluation of Project Alternative and Constraints | | | | 10,000.00 |
| 1.4. Pre- and Post Construction Project Management | | | | 5,000.00 |
| 1.5. Preliminary Engineering Analysis | | | | 8,000.00 |
| 1.6. Economic Analysis (cost estimation and funding source analysis) | | | | 7,000.00 |
| Sub-total | | | | 65,000.00 |
| **2. Engineering Studies and Design Plans** | | | | |
| 2.1. Engineering and Restoration Analysis | | | | |
| a. Topographic Survey and Mapping | | | | 15,000.00 |
| b. Hydrologic Study | | | | 10,000.00 |
| c. Geotechnical Study | | | | 10,000.00 |
| d. Restoration plan | | | | 20,000.00 |
| 2.2. Engineering Design Plans and Specifications | | | | |
| a. Grading Analysis and Design | | | | 10,000.00 |
| b. Drainage Analysis and Design | | | | 10,000.00 |
| c. Hydraulic Analysis and Design | | | | 15,000.00 |
| d. Erosion Control Planning | | | | 5,000.00 |
| e. Landscape and Restoration Plan | | | | 15,000.00 |
| f. Irrigation plan | | | | 5,000.00 |
| g. Construction Documents (specifications and BID package) | | | | 10,000.00 |
| h. Stormwater Pollution Prevention Plan (SWPPP) | | | | 5,000.00 |
| Sub-total | | | | 130,000.00 |
| **3. Permitting** | | | | |
| 3.1. Project Permitting | | | | 50,000.00 |
| 3.2. Permit Fees | | | | 20,000.00 |
| Sub-total | | | | 70,000.00 |
| **4. Project Implementation** | | | | |
| 4.1. Alternative 1 - Multi-Use Wetland/Riparian/Water Supply Facility | | | | |
| a. Wetland restoration | Acres | 40 | 45,000.00 | 1,800,000.00 |
| b. Stream restoration | LF | 2000 | 100.00 | 200,000.00 |
| c. Water Storage and Supply Facility | | | | 100,000.00 |
| d. Trails and Interpretive Boards | | | | 50,000.00 |
| Sub-total | | | | 2,150,000.00 |
| 4.2. Alternative 2 - Wetland/Stream Restoration for Mitigation of PVWMA Projects | | | | |
| a. Wetland restoration | Acres | 18 | 45,000.00 | 810,000.00 |
| b. Stream restoration | LF | 2000 | 100.00 | 200,000.00 |
| c. Trails and Interpretive Boards | | | | 30,000.00 |
| Sub-total | | | | 1,040,000.00 |
| 4.3. Alternative 3 - Wetland and Riparian Habitat Restoration | | | | |
| a. Wetland restoration | Acres | 45 | 45,000.00 | 2,025,000.00 |
| b. Stream restoration | LF | 3000 | 100.00 | 300,000.00 |
| Sub-total | | | | 2,325,000.00 |
| 4.4. Alternative 4 - Wetland Habitat Restoration | | | | |
| a. Wetland restoration | Acres | 45 | 45,000.00 | 2,025,000.00 |
| b. Trails and Interpretive Boards | | | | 30,000.00 |
| Sub-total | | | | 2,055,000.00 |
| | | | | |
| **5. Project Monitoring and Maintenance (annual cost)** | | | | |
| 5.1. Biotic Monitoring | hr | 120 | 100.00 | 12,000.00 |
| 5.2. Maintenance Activities (repair berms and maintain vegetation) | hr | 240 | 125.00 | 30,000.00 |
| Sub-total | | | | 42,000.00 |

Table 7.6 Summary of Total Project Costs for Each Alternative Enhancement Plan Upper College Lake Restoration Project

| | Project Altenatives | | | |
|---|---|---|---|---|
| **Description** | Alternative 1: Multi-Use Wetland/Riparian/Water Supply Facility | Alternative 2 - Wetland/Stream Mitigation Project | Alternative 3 - Wetland and Riparian Habitat Restoration | Alternative 4: Wetland Habitat Restoration |
| 1. Planning and Feasibility Analysis | 65,000.00 | 65,000.00 | 65,000.00 | 65,000.00 |
| 2. Engineering Studies and Design Plans | 130,000.00 | 130,000.00 | 130,000.00 | 130,000.00 |
| 3. Permitting | 70,000.00 | 70,000.00 | 70,000.00 | 70,000.00 |
| 4. Project Implementation: | 2,150,000.00 | 1,040,000.00 | 2,325,000.00 | 2,055,000.00 |
| 5. Annual Monitoring and Maintenance | 42,000.00 | 42,000.00 | 42,000.00 | 42,000.00 |
| Total Project Sub-total = | 2,457,000.00 | 1,347,000.00 | 2,632,000.00 | 2,362,000.00 |
| Contingency (10%) = | 245,700.00 | 134,700.00 | 263,200.00 | 236,200.00 |
| **Total Project Cost =** | **$ 2,702,700.00** | **$ 1,481,700.00** | **$ 2,895,200.00** | **$ 2,598,200.00** |

# 8. Management Planning and Implementation Issues

## 8.1. Introduction

There exist a variety of issues and potential constraints that can affect the implementation of enhancement projects throughout the Pajaro Valley. Project permitting can be a cumbersome and expensive process that at times can be an obstacle or disincentive for private landowners and public agencies to move forward with projects located in potentially sensitive habitat areas. Limited technical and financial resources have and will continue to affect project implementation. A lack of planning, coordination and collaboration between private and public parties has also caused project delays and/or suspensions. Little post project monitoring or evaluation has been carried out so that limited benefit-cost information is available for many best management practices in use or proposed in this plan. The following sections describe management planning and implementation issues and actions recommended to improve the planning and implementation of enhancement projects in the region.

## 8.2. Permitting

### 8.2.1. Background

Throughout the Pajaro Valley region many private landowners and farmers are interested in adopting conservation practices that can reduce erosion and improve water quality, such as stream bank stabilization measures and other drainage improvements. However, securing permits to implement these types of projects can generally require approval from a multitude of agencies, creating a process that can be complex, costly, and time-consuming. In contrast to the financial incentive to improve crop production, practices designed to improve water quality and protect sensitive habitat resources present uncertain economic returns. When faced with multiple permitting processes and uncertain outcomes from agency reviews, the adoption of some conservation practices is very limited.

For example, projects located in a riparian corridor can require several permits from local, state, and federal agencies. The following is a brief description of some of the permits that may be required for a particular project:

**Santa Cruz County.** The County of Santa Cruz will require that a grading permit and a riparian exception be obtained prior to their approval of the project.

**California Department of Fish and Game (CDFG).** A Streambed Alteration Agreement will be required. If the Santa Cruz County Resource Conservation District undertakes the project, then a 1601 permit would be required, and if the private landowner applies for a permit, a 1603 permit is required.

**US Corps of Engineers (USCOE).** A USCOE Section 404 permit is required to carryout work within any jurisdictional waters of the US.

**California Regional Water Quality Control Board (RWQCB).** A Section 401 Water Quality Certification from the Regional Water Quality Control Board (RWQCB) is required, which is part of the Section 404 permit process, but obtained directly from the RWQCB.

**Other Agencies.** Because the project would be conducted in a riparian corridor with potential endangered or sensitive species, the project may also be reviewed by other resource agencies, including the National Marine Fisheries Service and the US Fish and Wildlife Service.

The process to secure the individual permits from the various agencies is a disincentive for private landowners to adopt or undertake projects to reduce non-point source pollution and enhance habitat. Landowners and growers are likely to avoid conservation activities if the administrative and economic barriers exceed the potential benefits. Therefore, a challenge in implementing water quality and habitat enhancement activities in the Pajaro Valley will be to remove these disincentives.

Following the success of the coordinated permit program for Elkhorn Slough, Santa Cruz County has the potential to create a "user-friendly", streamlined permit program to promote the adoption of restoration and resource conservation efforts required to address water quality and habitat issues in the county. As described below a joint effort is underway between the County of Santa Cruz Planning Department, the Resource Conservation District, the California Coastal Conservancy, the Natural Resource Conservation Service, and Sustainable Conservation to develop, maintain, and promote a permit coordination program.

### 8.2.2. Permit Coordination

Sustainable Conservation, a nonprofit environmental organization, in partnership with the Natural Resource Conservation Service (NRCS) and Resource Conservation District (RCD), has designed and implemented a unique and innovative program, called the Partners in Restoration (PIR), to improve water quality, enhance wildlife habitat, and preserve agricultural resources. The PIR creates a one-stop regulatory permitting process for landowners interested in implementing voluntary conservation projects to control erosion and sedimentation and enhance natural resources. Permit coordination is typically issued that may include special conditions on the timing, location, and methods of installation to avoid or mitigate negative impacts on water quality, sensitive species, and important habitat.

Initiation of a permit coordination program requires cooperation from all responsible agencies, a lead agency (with a financial commitment to carry the program once it is approved), and a funding source to administer the development of the program. Once the project is underway it will involve a multi-step process that can take two years to set up. The overall coordination strategy required to setup a permit coordination process involves the following steps:

- Convene agencies
- Tour representative sites and practices
- Develop watershed-or area-specific conditions
- Negotiate agreements with agencies
- Conduct an interagency review and approval process
- Conduct public review process
- Complete permit applications and program manual/guide
- Initiate program

- Conduct periodic evaluation and progress reports

### 8.2.3. Experience in the Elkhorn Slough Watershed

The permit coordination program was approved in 1998 for Elkhorn Slough to stem extreme erosion rates. Recognizing that many of the target growers had limited financial resources, language barriers, limit support or contact with UCCE services, and highly erosive soils, the NRCS and the RCD with the help of Sustainable Conservation developed agreements with all agencies to initiate a permit coordination process to reduce obstacles for projects or practices that primarily reduce soil erosion. The program pre-approved 10 soil and water conservation practices to be used by farmers and landowners to enhance natural resources. These practices were carefully developed so that their implementation would avoid or mitigate negative impacts on water quality, sensitive species, and habitats. After three years, twenty-six project sites, using 47 practices had been completed. By 2002, projects enrolled in the program have the combined effect of preventing an estimated 30,603 cubic yards (41,314 tons) of soil from entering sensitive wetlands of Elkhorn Slough. The practices reduced upland agricultural soil erosion, stabilized gullies, and protected stream banks.

The success of the program is based on the reduction of the institutional disincentives to improve land management. Using this program, the projects were designed more quickly, implemented more efficiently, and perhaps installed with fewer costs. The program creates a 'one-stop' permit process for pre-approved conservation practices combined with technical and financial assistance programs from the NRCS and the RCD. At the same time, regulatory agencies have developed an efficient watershed-level review process that fulfills their legal requirements.

Implementation of the program has presented some important challenges that have caused project delays. These include lack of grower or owner commitment to complete projects, workload backlog caused by limited staffing resources, and encountering sensitive species at project sites that have required project modifications. The number of referrals has exceeded the capacity for the NRCS and RCD staff to provide the number of designs requested. As an alternative, program staff have recommend on-farm treatments that do not require complex designs or permits.

Implementing the program requires a large investment for NRCS and RCD staff. Without special funding to develop and maintain this permitting system, the NRCS and RCD's would not have sufficient resources available to implement the program. In addition, both NRCS and RCD staff must be trained in the subtleties of the permitting and interagency agreements, such as memorandum of understandings (MOUs). During the initial startup period of the project the timing and implementation of the number of projects permitted in a given year may be constrained by limited staff resources available at the NRCS and RCD.

### 8.2.4. Current Proposal Permit Coordination Programs in Santa Cruz County

The Santa Cruz Resource Conservation District is currently undertaking a Permit Coordination Project with the Coastal Conservancy and Sustainable Conservation to begin in December, 2002. Sustainable Conservation is a non-profit from San Francisco that has facilitated similar programs in the Elkhorn Slough and Salinas River watersheds. The Santa Cruz Permit Coordination effort attempt to setup a countywide program to directly support projects identified in assessment and enhancement processes. The intent of the project is to establish a program that will facilitate projects being permitted in a timely and cost-effective manner and to identify strategies to induce long-term changes that support restoration and enhancement projects.

## 8.3. Lease Agreement

A primary intent of agricultural lease agreements is to ensure that the land and associated infrastructure is maintained according the desires of the landowner. Leases may vary from year to year or on a multi-year, longer-term basis. Multi-year or longer-term leases generally provide more opportunities and benefits for the conservation-minded owner who wishes to formally or informally include specific practices (e.g cover cropping) as a lease condition. Multi-year leases may also provide substantially more incentives to the renter to implement (wholly or with cost-share) certain conservation practices that can be "amortized" over the period of the lease.

## 8.4. Coordination and Implementation of Ditch Maintenance & Drainage Improvements

### 8.4.1. Overview

Substantial erosion and sedimentation problems throughout the Pajaro Valley are attributed to aged, undersized and/or poorly maintained drainage infrastructure that includes roadside drainage ditches, culverts, drainage waterways and in some instances stream channels. Many of the drainage problems have also become exacerbated from land use conversions (e.g. conversion from orchards and pasture to row crops) in the area, which has either increased the amount of impervious surface or reduced field infiltration resulting in increased runoff flows.

The County of Santa Cruz is the lead agency responsible for the maintenance and repair of the majority of the road and drainage infrastructure in the area. Caltrans is responsible for drainage infrastructure installed along Highway 129. Historically, the County of Santa Cruz Road Department has maintained roadside ditches and the Pajaro Storm Drain Maintenance District (PSDMD) has maintained drainage courses, waterways, and streams. Discussions with the County's Drainage Division identified a number of constraints influencing the maintenance of ditches and natural channels, primarily related to budget, permitting, and planning. Drainage improvements typically have been undertaken in a piecemeal fashion and comprehensive drainage plans do not exist for the area. Drainage improvements are generally carried out to accommodate new infrastructure and/or development or to repair damaged facilities. A comprehensive drainage study(s) is needed to evaluate existing drainage and waterways and to identify and plan alternative drainage improvements to accommodate the conversion of land use and the drainage modifications that have occurred over the past fifty years in the area.

During the landowner contact phase, there were a number of discussions concerning the history and current status/activities of the Pajaro Storm Drain Maintenance District (PSDMD). Long-time landowners and managers have expressed concern regarding, in their view, the decline in maintenance activities during the past 30 years. All were unclear as to the budget and priority decision-making process for the PSDMD and indicated a desire to reestablish a direct working relationship with those responsible.

Currently, no clear mechanism allows landowners or land managers to work cooperatively with the appropriate County departments or organizations for the timely and effective maintenance or improvement of drainage infrastructure. Any proposal to better coordinate ditch and drainage improvements and maintenance in the Lower Pajaro is critical to address long-term erosion and sedimentation issues in the area. A coordinated effort between private and public entities to plan, coordinate, and implement drainage activities should be facilitated under the jurisdiction of the PSDMD and the County of Santa Cruz.

It should be noted that the Santa Cruz County Department of Public Works was recently awarded a grant to initiate the Phase II National Pollution Discharge Elimination System storm water program for the unincorporated areas in the county. One of the tasks under this program could be to improve the coordination and communication between the Public Works Department and private landowners, specifically in the Pajaro Valley region. The SCCRCD and other organizations should encourage the County Public Works Department to allocate a reasonable amount of funds to the Pajaro Valley to improve coordination and planning of stormwater and drainage management activities.

### 8.4.2. Historical Drainage Planning and Maintenance Activities

The origins of the PSDMD go back to the original formation of the Drainage Improvement District 3 (DID-3) for the Pajaro area in 1937. This was prior to the California State Act called the Storm Drain Maintenance District Act of 1939. The Act states that each County Board of Supervisors shall be responsible for the formation, supervision, and dissolution of such districts. The Act states that "… maintenance may include, the cleaning, repairing, renewal, replacement, widening or straightening of existing storm drain structures, water courses or drainage channels, and the installation of appurtenant structures when necessary for the adequate functioning of such drainage facilities". The PSDMD was not formed until 1947, concurrent with the construction of levees along the Pajaro and Salsipuedes channels. At that time, the PSDMD included only the Pajaro and Salsipuedes, outside of the area covered by the DID-3. In the succeeding years, the District annexed other areas in the Pajaro Valley, including the sloughs, areas in Corralitos, and extending east to Murphy's Crossing. Until 1961, the PSDMD was the County Surveyor's function. It is assumed that County Public Works took responsibility for the PSDMD and the original DID-3 when the County Surveyor's office and the Public Works Department were consolidated. In 1968, the DID-3 was dissolved and that area annexed to the PSDMD. As early as 1974 the Santa Cruz Local Agency Formation Commission (LAFCO) proposed the formation of Zone 7 to enhance flood control efforts along the Pajaro River. However, it was not until 1992 that Zone 7 was formed to specifically address flood control measures in the main channels of Salsipuedes Creek and the Pajaro River, the original charge for the PSDMD.

Local knowledge suggests that the period of the late 1960's to '70's was a critical transition period in the management of drainage in the Pajaro Valley. This is, in part, due to the difficulties that the County began to experience due to increased regulatory activity (e.g. endangered species listings), resulting in new state and federal permit requirements. Concurrently, the size and priorities of the County had an important qualitative effect, likely changing the nature of communication and decision-making. Prior to this period, landowners or growers knew whom to call and County employees were more autonomous and therefore responsive to public input. Following this transitional period, this system began to deteriorate, timely or proactive actions by the County became mired in permit processes, and prior management tools and methods were questioned or prohibited, while the public grew frustrated, based on a perceived lack of accountability and action.

However, even in 1967 it was apparent to some County staff that some policy should be set for an approach to some specific channels or areas. While this was in the context of developing a sound right-of-way program for the PSDMD, it pointed to the fact that the piecemeal development and operation of the PSDMD was not guided by a comprehensive planning process. The district is still managed by the Board of Supervisors, who have combined this with oversight of Zone 7. Decisions regarding budget allocations and project priorities are largely set by the County Public Works Department, and occur concurrently with decisions for Zone 7 projects. A review of recent budgets for Zone 7 and PSDMD indicate the majority of funds allocated for planning projects, have been allocated for Zone 7 flood control efforts in the Pajaro and Salsipuedes, rather than the broader area served by the PSDMD.

The need for coordinated planning and implementation of ditch maintenance and restoration is demonstrated by comments and observations of Drainage Division staff. Maintenance efforts in the San Andreas and Watsonville Slough areas have often exceeded budgetary allocations due to large volumes of sediment due to "… erosion from adjacent or upslope farmland". Maintenance reports reflect continual excessive sedimentation problems in certain areas, but prescriptive actions or plans to mitigate these 'problems' have not routinely been developed. Staff noted that problems can be confounded by the lack of granted access to certain properties, rapid conversions in crops and production systems, as well as, difficulties in maintaining relationships with ever-changing tenant growers. Budgetary constraints are worst following unusually heavy or intense winter storms, when emergencies or critical erosion events deplete the current year budget for the PSDMD. Conversely, landowners and growers may be confused as to their responsibilities when utilizing County-maintained drainage structures. There is the occasional lack of clarity concerning private and public responsibilities for management of ditches. There is a general lack of awareness by owners and growers concerning the limitations posed by permit requirements and budgetary priorities. Further landowners and growers may not fully appreciate the impact of their actions on "downstream" private and public infrastructure.

In summary, there is a general need for additional outreach efforts to Pajaro Valley growers and landowners to provide technical information, financial assistance, and cooperative oversight of drainage infrastructure management. A mechanism is needed to improve communication and provide some public input into the prioritization of maintenance activities carried out by the PSDMD. Currently, Drainage Division staff maintains one on one relationship with many owners and growers; however, County staff have not engaged community members in the decision making process within the PSDMD.

### 8.4.3. Facilitating Coordinated Drainage Planning and Improvements

Current initiatives related to the Monterey Bay Sanctuary Agricultural Lands Plan for water quality protection include the formation of Farm Bureau Watershed Workgroups. Concurrently, the SCCRCD is pursuing a more aggressive program focusing on water quality protection and is initiating a number of grant-funded local projects related to sediment source mitigation, ditch stabilization and maintenance. As a result, there is increasing communication and cooperation between the RCD and the Drainage Division.

The Natural Resource Conservation Service recently formed a local area working group to coordinate and evaluate resource conservation projects throughout the Counties of Santa Cruz, Monterey, and San Mateo counties. Currently, this committee is comprised of various local agency representatives, but there is no consistent landowner or grower participation in this workgroup. However, with landowner, grower and County staff participation, the NRCS local area workgroup may provide a forum for decision-making and resource allocations under the PSDMD. This workgroup could also begin to develop an overall planning, outreach, and action plan for drainage issues in the Pajaro Valley. Currently, the NRCS workgroup provides some advisory function that may target specific local areas for prioritization and development of funding sources for planning and project implementation. On a broader level, the existing workgroup could be used to, improve communication, policy and planning, and pubic-private coordination without creating another parallel process that may duplicate effort.

The figure below provides an outline for such a cooperative mechanism to develop broader coordination and planning for drainage and sediment management in the Pajaro Valley. This would utilize existing or planned watershed groups, workgroups, and existing agencies. The process would place the RCD in a central role as a direct liaison between the community groups and the County staff and ultimately the Board of Supervisor, the decision-making body for the PSDMD.

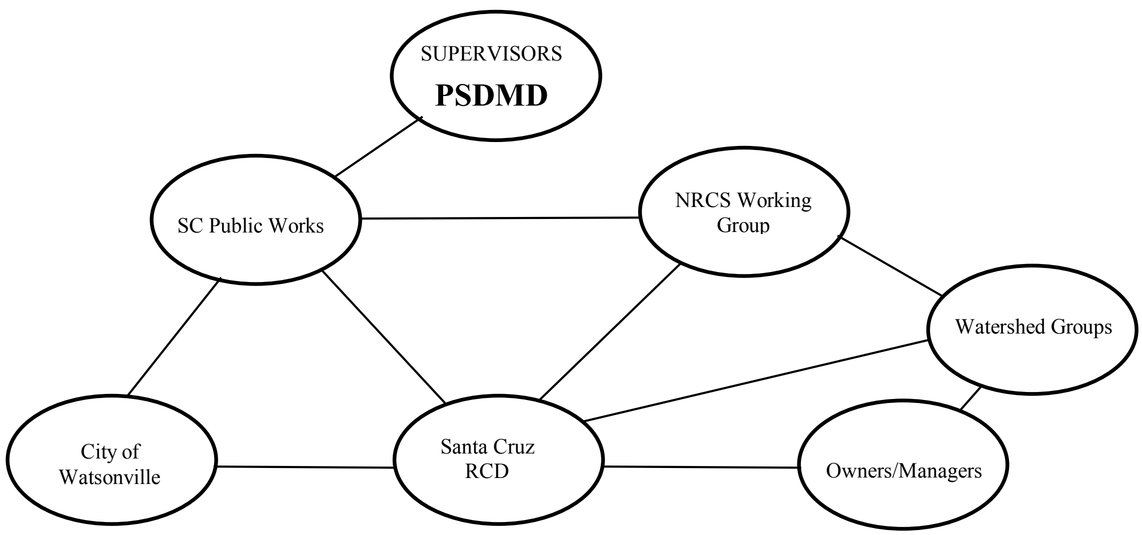


Figure 8.1 Linkage of private and public interests
for coordinated drainage management

8.4.4. <u>Landowner/Grower Ditch Maintenance/Watershed Groups</u>

Another alternative to provide for ongoing maintenance and planning activities within the PSDMD would be to create neighborhood maintenance/watershed groups that would operate semi-autonomously under the jurisdiction of the PSDMD. Each maintenance board would be responsible for a watershed area(s) defined by the PSDMD and the Maintenance Board. The purpose of the Maintenance Board would be to identify, prioritize, coordinate, supervise and carryout ongoing agricultural and roadway ditch maintenance activities in the watershed area. The activities would be either entirely and/or partially funded by the PSDMD. Depending on available funds and priority of work, the Maintenance Board could potentially raise funds directly from landowners or from other sources such as grants in order to cover the cost of the entire project.

The formation of a maintenance/watershed group may be initiated by assistance from the Santa Cruz County Resource Conservation District and/or from other organizations, such as the County Farm Bureau program.

Developing a maintenance group would entail several tasks, including:

- Delineating a maintenance sub-district area (with the PSDMD)
- Forming a maintenance group leadership (i.e. officers)
- Developing Landowner Maintenance Agreement
- Appointing a maintenance supervisor/coordinator
- Preparing an annual maintenance budget
- Carrying out routine ditch maintenance activities
- Special Projects
- Board Meetings
- Preparing Annual Report for Maintenance/Watershed Group and PSDMD

**Maintenance Sub-District Area.** The PSDMD (Board of Supervisor) with input from a landowner group would delineate a sub-district area, which would become the jurisdictional area of the maintenance group. For example, there is currently a watershed working group being created in the Coward Creek watershed. The watershed in this area could ultimately become a maintenance sub-district area.

**Maintenance Group Leadership (Board).** A Maintenance Board would be formed, which would include a set number of members. The Maintenance Board would consist of a majority of landowners, a selected number of county staff and possibly a board or staff member of the RCD. The Maintenance Board would have officers, including a president, secretary, and treasurer, who would be responsible to conduct the meetings, prepare reports, and maintain the board's finances. The board would conduct routine meetings to identify and plan projects, and approve annual budgets for maintenance and other activities recommended by the Board. The meeting would also be a forum to discuss drainage and other business issues. The Maintenance Board would submit an annual budget to the PSDMD to solicit funds for maintenance activities. Depending on the amount of work to be undertaken and funding available from the PSDMD, the board may elect to impose a maintenance fee to finance the remaining activities planned for the year. Lastly, the Maintenance Board would periodically prepare reports for the landowners in the Sub-District Area and the PSDMD.

**Landowner Maintenance Agreement.** An initial task of the Maintenance Board would be to prepare a general Maintenance Agreement (Agreement). The Agreement would specify several conditions that would be met by each landowner participating in the maintenance program. Typically, an Agreement will include a fee schedule for various types of maintenance activities, and conditions for granting maintenance easements and/or access to carry out annual maintenance work. The Agreement could include provisions for cost sharing for landowners who choose to undertake or assist in maintenance activities, and additional provisions specifying minimum self-monitoring requirements (such as reporting the type of project and location, quantity of material removed, location where material is disposed and other pertinent activities). The Agreement could include provisions for the reuse or disposal of spoils excavated from the maintenance projects. The Agreement could include provisions to limit potential liability and require mediation as a method to settle disputes of claims for potential damages. The Agreement would include conditions for conducting annual inspections, as well as outlining the minimum information required in either monthly inspection and/or annual reports prepared for the PSDMD and other agencies that may be required.

**Maintenance Supervisor/Coordinator.** The Maintenance Board would select a volunteer community member to coordinate, schedule, and oversee all annual maintenance activities. The maintenance supervisor would coordinate activities between the landowners and the County Public Works Department. The Maintenance Supervisor would also work closely with the County Public Works Department drainage manager to review and coordinate work. The supervisor would be responsible for tracking/monitoring all maintenance activities and prepare an annual report that describes the type, quantity, and location of work completed during the maintenance period. The supervisor would either exchange their time for an equivalent amount of maintenance work carried out on their property and/or for a wage set by the Maintenance Board. The supervisor position could rotate annually or every few years depending on the discretion of the Maintenance Board and/or the supervisor.

**Annual Budget.** A key element of the program will be to prepare an annual maintenance budget for all planned maintenance activities in the area. The budget would be presented to the PSDMD in order to solicit maintenance funds from PSDMD, and to collect additional landowner fees, as required, to complete projects identified by the Maintenance Board

**Annual Maintenance Activities.** Under the direction of the Maintenance Supervisor, routine maintenance activities would be carried out, including removal of sediment from agricultural and roadside ditches, reshaping and improving existing ditches, repair of gullies and damaged culverts, removal of accumulated debris in ditches and at road crossings and possibly installation of erosion control measures and/or stabilization of eroded ditch banks.

**Special Projects.** Once the Maintenance Board has become established and has successfully completed routine maintenance activities, the Maintenance Board may elect to undertake some type of special project(s), such as applying for grants monies to carry out a comprehensive drainage study, a stream restoration project or other type of enhancement project.

**Board Meetings.** The Maintenance Board would conduct community meetings on a routine basis, such as quarterly or semi-annually. The meetings would be held to discuss drainage and maintenance issues and to plan upcoming maintenance activities. The meetings would also provide a forum for community members to become acquainted with County staff appointed to the Maintenance Board and to discuss other watershed issues.

**Annual Report.** The Maintenance Board would prepare annual reports that summarize activities completed to date including a year-end fiscal report, and recommendations for following year activities. This report would be submitted to the PSDMD, and used to solicit funds to carryout the following year's activities.

## 8.5. Technical Assistance and Project Coordination

Over the past several years, various agencies and organizations have expanded their resource conservation programs substantially, and with the recent approval of the Farm Bill, additional financial and technical resources will be available to NRCS and landowners for conservation projects in the Pajaro Valley. Based on the discussions with various agency staff and landowners, a variety of technical assistance needs have been identified, which are discussed below. Five major areas have been identified, including:

- Field Assessment and Project Support
- Engineering Design
- Cost-Benefit Information
- Project Coordination
- Project Evaluation
- Priority Activities

**Field Assessment and Project Support.** One-on-one field assessment activities are a major focus of the RCD and NRCS staff to properly assess and design conservation projects. This approach is critical to the success of long-term soil conservation efforts in the region; however, the work is very resource intensive. Additional technical field staff is needed to conduct the field assessment activities with landowners and growers to identifying on-farm management practices or projects to stabilize gullies and streambanks.

Permit requirements for a range of proposed and potential projects can be challenging, particularly in extending timelines for project implementation, while trying the patience of landowners or growers. Project support by RCD or other agency field staff, have assisted landowners through the permitting phase of projects, however, this phase alone can delay a project to the effect that field staff resources are depleted and the season window closes, so that project completion is routinely pushed to the following year.

**Engineering Design.** Many conservation projects require civil engineering support as part of the design and permit phase. Currently, the RCD relies on engineering support provided by the NRCS. This has been particularly critical in the past where EQIP funds are involved, as this NRCS cost-share program does not cover the cost for engineering services. Near-term changes in the EQIP program may partially or fully cost-share engineering enabling projects to move forward in a more timely fashion. While this change may allow the RCD to use private engineering consultants, this may not fully resolve the immediate problems related to a backlog of engineering supported presently needed for existing RCD and NRCS projects. Currently, there is up to an 8 month backlog for engineering support in the Monterey Bay region, covering the Monterey, Santa Cruz and San Mateo Counties.

**Benefit and Cost Information.** Currently, there is limited information to demonstrate the net financial benefit for implementing conservation practices. However, the long-term benefits for any conservation project should be determined as part of the planning process. This will require a clear understanding of farm economics and the costs of implementing recommended practices. Currently, the RCD, NRCS and UC Cooperative Extension (UCCE) are compiling performance and cost data to initiate a database that will provide growers and landowners baseline information to evaluate the cost and benefits of employing conservation projects. An area of specific need will be the development of a marginal cost analysis model to determine the economic impact to rental values when land is converted to habitat, riparian or vegetated buffer strips, or some other conservation structure (e.g. sediment basin).

**Project Coordination and Outreach.** Currently, there are several different agencies and organizations carrying different programs aimed at on-farm soil conservation practices and improving water quality. The traditional role for the RCD will include acting as liaison between land users and resource/regulatory agencies and offering workshops and trainings for land users on topics they request. These activities are on-going and will be enhanced by special project grants in targeted priority areas. Another key role of the RCD will continue to assist in the coordination of the various conservation programs underway, such as federal cost-share or local watershed assessments aimed at bringing resources to the watershed, and to ensure landowners understand their role and how to participate in the different programs.

The RCD/NRCS and other technical assistance providers should continue to work with Farm Bureau watershed working groups or other growers, to provide technical needs identified by them as part of the Agricultural Water Quality Program. Technical assistance groups, including private consultants, can also be valuable resources to the working groups of growers for understanding the linkage between problems and potential solutions.

When no watershed working group of growers has been established to assist growers to comply with water quality regulations, and there are requests for services, technical assistance groups like the RCD or local consultants should coordinate with the Farm Bureau Water Quality Program keeping them informed of related work going on in their region. However, requested technical assistance should still be provided while actively encouraging the land user to assess water quality concerns and be aware of local groups to assist them (such as the Farm Bureau Program).

The RCD and other organizations should continue outreach efforts to promote alternative cost-share assistance programs, such as the NRCS's EQIP and other similar programs to landowners and growers. With changes in these programs, resulting from the new Farm Bill, there will be confusion concerning length and monetary cap of contracts, responsibilities of cost-share recipient after the installation or modification, as well as, technical follow-up requirements.

**Project Evaluation.** Over the last several years the, RCD, NRCS, UCCE, and other agencies have implemented various conservation projects throughout the Monterey Bay Region. However, limited cost or performance data are available to critique the projects and determine their effectiveness beyond a qualitative review of the practices with the landowner and/or manager, often in a field survey format. A vital component of future projects will be to have a post project evaluation process. Currently, there is not a standardized method to monitor and evaluate conservation practices. The RCD and NRCS will need to develop a standardized method to monitoring and evaluating practices so that data for different sites and practices will be comparable.

**Project Priorities.** Over the next few years, the RCD and NRCS will continue to prioritize projects in the Watsonville Sloughs and other watershed areas in the Pajaro Valley. These projects will include the establishment of grass along the entire length of the Beach Road ditch, construction of sediment detention basins and buried drain structures in the highly erodable San Andreas area adjacent toWatsonville Slough, gully repair, and habitat restoration in the Buena Vista Rd. area. Another on-going project will be assisting in drainage improvement projects in the Thompson Road area in the Coward Creek watershed.

Generally, future RCD plans for actions in the Pajaro Valley to reduce erosion and improve water quality include:

- Promoting the use of vegetation (grass-lined ditches and roadways) for erosion control and management of field run off;
- Promoting irrigation system efficiency and water conservation practices;
- Using available benefit & cost information, assist growers in the assessment and selection of conservation practices;
- Providing ongoing technical assistance in the design, construction and maintenance of conservation practices
- Coordinating different land users, regional agencies and potential funders to develop projects to capture, store and reuse runoff as an alternative source of agricultural water supply and to protect water quality
- Developing project evaluation procedures to monitor and track practices (such as the use of erosion pins, photo points, documentation, and water quality testing)
- Nutrient budgeting – working with local consultants, NRCS or UCCE to emphasize the benefits of nutrient budgeting to land users to improve soil fertility, reduce production costs, and protect water quality; and
- Assisting watershed groups and individuals identify and apply for funds to implement projects through NRCS's Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Incentives Program (WHIP) and other potential funding sources. (Facts sheets describing the EQIP and WHIP programs are presented in Appendix F.)

## 8.6. Safe Harbor Agreements

### 8.6.1. Background

The US Fish and Wildlife Service and Environmental Defense Fund (EDF) developed the Safe Harbor Agreement as a mechanism to allow landowners to protect listed species without being penalized. The Agreements are intended to be an incentive for private landowners to carryout enhancement projects to conserve soil and water resources that protect endangered species. Agreements have been made across the country and cover over 2 million acres of land as of the spring of 2002. Essentially these agreements allow landowners to create, restore, or maintain habitat for endangered species while protecting them from new land use restrictions that might be applied under the Endangered species act. There are several successful models to encourage, promote and administer these agreements, but they typically include a consortium of NGOs, public agencies and private landowners. A diverse set of landowners have entered into these Safe Harbor Agreements including private forest owners, ranchers, residential property owners, and corporate landowners.

Private land holdings constitute significant opportunity to protect endangered species, but the potential that new land use restrictions would reduce property value is a strong disincentive to provide habitat for endangered species, which the Safe Harbor concept attempts to reverse.

Safe harbor agreements are between the federal agency responsible for protecting the species (U.S. Fish and Wildlife Service or National Marine Fisheries Service for anadromous and marine organisms) and either a private landowner or an intermediary. In the case of a private landowner, some specific activity would be performed that benefits an endangered species in exchange for a guarantee that no additional regulatory restriction related to the newly restored or enhanced habitat will occur. In the second case, the intermediary (e.g. USDA-NRCS, California Department of Fish and Game, county RCDs, or even a private conservation organization) can develop a Safe Harbor program for a specific area, i.e. a county or watershed or group of counties or watersheds. The intermediary creates an agreement that allows it to administer an umbrella agreement for private landowners, which removes much of the workload from individual landowners.

Under a Safe Harbor Agreement, landowners can directly enhance grasslands, riparian zones, and other lost or degraded habitats that are potentially suitable for endangered species or indirectly by installing conservation practices that benefit the land and land user in other ways. Removing non-native species also qualifies for safe harbor agreements when endangered species are impacted by these species (e.g. bullfrog may increase the susceptibility of red-legged frog to local extinctions). Safe harbor agreements can be used to reintroduce an endangered species into areas where it formerly occurred.

8.6.2. Steps To Enter a Safe Harbor Agreement

1. Determine if endangered species occur in your area and if land contains suitable or potentially suitable habitat for such species. For examples many areas in the Pajaro Valley are considered to be potential habitat for the red-legged frog a federally listed endangered species.

This information can be obtained by contacting the USFWS, NRCS, CA-DFG, Santa Cruz County Resource Conservation District, or knowledgeable and reputable organizations or consultants.

2. Determine if activities that benefit this species are consistent with land management objectives.

Information on what actions can benefit the species can also be obtained from resource agencies (USFWS, CDFG, NRCS, RCD or local consultants).

3. Is there an umbrella safe harbor program in the area of the property?

California Department of Fish and Game can advise on current umbrella agreements in the state. Currently, no umbrella agreement has been developed in Santa Cruz County.

4. Determine Baseline Condition.

Safe harbor agreements do not allow landowners to harm endangered species that are already present on their property, therefore, assess whether an endangered species already inhabits the property. The willingness of landowners to enter into safe harbor agreements can depend this “baseline” condition. However, without advanced knowledge of what a baseline survey will reveal, landowners may avoid potential obligations by hiring a competent, independent biologist to examine the property carefully in advance of an official survey. As a result, the landowner can decide on whether a safe harbor agreement is appropriate. If the agreement will be under an umbrella safe harbor agreement, the intermediary, who should have a high degree of trust with the landowner, can keep the results of the baseline survey confidential unless the landowner decides to participate in the umbrella agreement. Both RCDs and NRCS have protected confidentiality clauses in their governing mandates. These should be provided to landowners concerned with privacy.

5. Specify Agreement Length and Obligations.

The duration of safe harbor agreements is negotiable. The USFWS will specify agreement time frames that will benefit endangered species, which will depend on the species, habitat type, and the planned habitat improvements. The landowner's obligation to undertake or maintain certain improvements for the specified time period should be consistent with the land management objectives. Agreements can also be terminated prematurely, although there may be some additional obligations worked out in the agreement if this occurs.

6. Trade of Safe Harbor Credits

Safe harbor agreements should specify how baseline conditions can be adjusted downward if the species disappears by uncontrollable or unanticipated reasons, e.g. predators, disease. Under umbrella agreements covering more than one property with multiple owners the landowner #1 may voluntarily agree to adjust the baseline upward as a form of trading safe harbor credits. In this case, landowner #2 may choose to destroy habitat for an endangered species, but will pay landowner #1 to increase their baseline upward to mitigate these destructive activities. The increased baseline will increase landowner #1’s obligations.

7. Access to Private Land

Under the safe harbor agreement, landowners are not obligated to provide public access to their lands. However, the agreements do provide access for the following activities: establish baseline conditions, evaluate compliance, and potentially capture and relocate species at the expiration of the agreement. The timing, frequency, advance notice requirements, and other aspects of such access are negotiated in the agreement with the landowner(s) or intermediary.

8. Impact on Neighbors

Safe Harbor Agreements can be developed so that obligations are non-transferable to neighboring parcels if migration of a species occurs from a restored or enhanced habitat. Safe Harbor Agreements can also be transferred or terminated with a change in landownership.

9. Safe Harbor Agreement as Public Record

All safe harbor agreements are published in the Federal Register. However, only if agreements are made with individual landowners are their names published. When agreements are made under umbrella agreements, only the intermediary is published. However, records kept by federal agencies about either type of agreement are public records and are generally subject to disclosure.

10. Linking Safe Harbor Agreement with Other Incentives.

Activities conducted under a safe harbor agreement (conservation easements, re-vegetation, exotic species removal, etc) can be funded by programs, such as the Conservation Reserve Program of the Department of Agriculture or land enrolled in the Wetlands Reserve Program, Wildlife Habitat Incentive Program, Partners for Wildlife Program of the Fish and Wildlife Service and the Environmental Quality Incentive Program.

## 8.7. Future Planning and Project Opportunities

### 8.7.1. Drainage Master Planning

PSDMD should allocate a percentage of annual funds to begin to conduct drainage studies in the subwatershed areas of the Pajaro Valley. The studies should include an assessment of existing drainage infrastructure, identification of key problem areas, and recommended improvement projects. Through a public review process the results of the drainage study(s) should be presented to joint committee of interested landowners and PSDMD staff to prioritize and select drainage improvement projects.

### 8.7.2. Technical Training and Evaluation

Over the past several years the RCD and NRCS has undertaken a variety of projects to address erosion control on agricultural lands. To transfer this experience to private landowners and other local agencies, ongoing technical workshops or trainings are recommended. The NRCS has also been allocated substantial funds to carryout agriculturally related environmental enhancement projects. Forums are needed to inform private landowners how they may apply for these program funds. The following describes a series of workshops that are recommended to address erosion and to promote environmental enhancement projects on private lands in the Pajaro Valley.

**On-farm Drainage Management.** Intensive agricultural practices in the Pajaro Valley have impacted drainage systems both on and off farmlands. Many of the existing drainage infrastructure accommodating this runoff install in public right-of-ways is aged and generally overloaded during periodic storm events. The RCD and NRCS should conduct a series of workshops to provide landowners and/or managers with current technical information concerning the management of onsite drainage. The workshop should cover basic concepts on rainfall-runoff estimation, common drainage problems, overview of drainage best management practices, cost, selection and design of drainage BMPS; and, lastly, timing and installation BMPs.

**Funding (Cost-Share) Opportunities.** Under the recently enacted national Farm Bill 2002, the federal government has made available substantial financial resources to environmental enhancement projects. Through the Environmental Quality Incentives Program (EQIP) farmers and ranchers may receive financial and technical assistance to install or implement structural and management conservation practices on eligible agricultural land. EQIP may pay up to 75 percent of the costs of certain conservation practices. Total cost-share and incentive payments are limited to $450,000 per individual over the period of the 2002 Farm Bill. The Wildlife Habitat Incentives Program (WHIP) is a similar program that encourages creation of high quality wildlife habitats that support wildlife populations of National, State, Tribal and local significance. Through WHIP, the NRCS provides technical and financial assistance to landowners and others to develop upland, wetland, riparian, and aquatic habitat areas on their property. Additional cost-share funds, targeted at environmental enhancement projects, are periodically available through the State, the RCD and non-governmental organizations. The RCD and NRCS should conduct a workshop(s) to inform private landowners of funding programs currently available.

**Biotechnical Bank Stabilization Practices.** Biotechnical bank stabilization methods as described in Section 6 of this plan utilize a combination of vegetation and structural measures to repair, stabilize and protect stream or waterway banks and reduce land loss from erosion. These methods are generally less expensive than conventional structural measures, are more widely accepted by resource agencies (i.e. easier to permit), provide more long-term protection once the vegetation becomes established, and can provide environmental enhancement opportunities on the property. A workshop for landowners or managers to introduce the concept of biotechnical bank stabilization methods is recommended. An important aspect of a workshop should be to stress the importance of maintaining adequate setbacks between fields and waterways and the use of vegetation to provide for long-term stabilization of stream channels.

**Water Conservation and Nutrient Management.** The Pajaro Valley Water Management Agency's water conservation program operates a mobile irrigation lab, The mobile irrigation lab conducts irrigation efficiency studies for individual growers and provide growers with a detailed assessment of the condition of their irrigation system, the efficiency of the pumping plant and irrigation distribution system. The results, if implemented, can typically reduce the amount of water and fertilizer used, providing direct savings to the grower, and many times inform growers that their pumping equipment is not operating properly, so that the equipment can be serviced before catastrophic failure, which typically occurs when water demand is critical and results in costly repair. The RCD, NRCS and other agencies should continue to promote the use of the PVWMA mobile irrigation lab. The PVWMA could also consider providing specific assistance to growers on fertilizer and soil nutrient management with a goal of reducing field losses of potential pollutants.

### 8.7.3. Project Monitoring and Evaluation

Over the past several decades the NRCS and other agencies have worked with landowners to install many practices. Limited resources have been available to construct the project and even less funds and staff resources are provided to conduct post construction monitoring and evaluation. Limited field data is available to allow for a benefit-cost analysis of BMPs. As projects are funded, dollars need to be allocated to post project monitoring and evaluation. Need to develop standardized monitoring and evaluation procedures.

### 8.7.4. Demonstration Projects

Demonstration projects are an important means to show how their application, function, benefits and costs. Ongoing outreach efforts by the RCD, NRCS and other organizations should continue to assist in the development of demonstration projects related to on-farm drainage and erosion control, water conservation and nutrient management, ditch maintenance and bank stabilization techniques. Landowners obtaining EQIP funds to carryout innovative projects should be encouraged to allow the NRCS and RCD to showcase the project.

### 8.7.5. Coordinated Research

Often agricultural research is not coordinated nor focused on priority issues, such as erosion control and nutrient management in full-scale demonstration projects. While many state and local technical resource groups (UCCE, NRCS, RCD) have been linked under the Sanctuary Agricultural Water Quality Alliance additional project proposal coordination would ensure that specific efforts are made to evaluate the performance and benefit-cost of local demonstration projects.

This section has identified several programmatic issues and activities that are affecting the planning and implementation of enhancement projects in the lower Pajaro River watershed. Several actions are recommended to improve the adoption of on-farm BMPs and stream enhancement measures, and the long-term maintenance of existing and future drainage infrastructure. Section Nine provides an outline for the planning and implementation of these activities, and estimates the technical and financial resource requirements and timelines.

### 8.8. Summary and Conclusions

The plan has identified various management, planning and implementation issues that are complex, institutionalized barriers that will require focused and persistent efforts to overcome. The SCCRCD, the Santa Cruz County Farm Bureau and other organizations are moving forward with several project initiatives to change and improve management and planning activities in the area. The following outlines the key issues and some actions that are underway that should improve management and planning activities in the Pajaro Valley:

#### 8.8.1. Project Permitting

Issues:

- Complex
- Costly
- Time consuming
- Disincentive for public/private landowners

Action:

- SCCRCD has applied for funding to initiate a Countywide Permit Coordination program for accepted practices in order to streamline permitting, reduce fees and time frame for approval process

Status:

- SCCRCD in process of securing grant funding to initiate process and the project will most likely take over two years to put into place.

#### 8.8.2. Ditch and Drainage Maintenance & Planning

Issues:

- No planning
- Lack of coordination
- Poor communication between public/private landowners
- Limited technical and financial resources
- Fear factor – liability issues

Action:

- The Santa Cruz County Farm Bureau (SCCFB) and/or NRCS/SCCRCD may facilitate a coordinated drainage planning and improvement projects with cooperative landowners

Status:

- SCCFB working with Coward Creek watershed group to formulate watershed planning activities

### 8.8.3. Technical Assistance and Project Coordination

Issues:

- Limited Field Assessment and Project Coordination
- Engineering design support needed
- Benefit-cost data on BMPs is hard to find or does not exist
- Improvements n Project coordination and evaluation
- Prioritization of activities

Action:

- NRCS/RCD/UCCE & NGOs coordinating the development of project monitoring and evaluation procedures
- NRCS may be hiring new engineers and possible contract with private consultants hire under future Farm Bill 2002 funds.
- NRCS/UCCE developing benefit and cost information to support selection and design of on-farm BMPs.

Status:

- Many of these activities are underway

# 9. Planning and Implementation

A series of demonstration projects and programmatic activities are outlined in this study. The demonstration projects in Section 7 include two bank stabilization projects, one on Green Valley Creek and a second on Coward Creek. The third project includes an extensive wetland and stream restoration project in upper College Lake. Section 8 presents a series of recommended programmatic activities, including the need for drainage master planning, technical training and evaluation projects, and additional demonstration projects. This section presents proposed planning and implementation activities that should be undertaken to implement the enhancement plan. Preliminary budgets and timelines have also been outlined for each proposed activity.

## 9.1. Demonstration Project Planning and Implementation

As described in Section 7, three demonstration projects are presented in the Enhancement Plan, including the Green Valley and Coward Creek bank stabilization projects and the Upper College Lake Restoration Plan. The following sections summarize the project budgets and timelines required for their implementation.

### 9.1.1. Green Valley and Coward Creek Bank Stabilization Projects

Table 9.1 presents a summary of the estimated cost for the projects and Figure 9.1 presents estimated timeline for engineering design, permitting and project implementation.

Table 9.1 Project Cost for Green Valley and Coward Creeks Bank Stabilization Projects

| **Project** | **Green Valley Bank Stabilization Project** | **Coward Creek Bank Stabilization Project** |
|---|---|---|
| Activity | Total Cost | |
| **1. Design and Permitting** | $ 17,000.00 | $ 32,000.00 |
| **2. Project Implementation** | $ 51,000.00 | $ 123,500.00 |
| **3. Project Monitoring and Maintenance** | $ 5,000.00 | $ 5,000.00 |
| Total Project Sub-total = | $ 73,000.00 | $ 160,500.00 |
| Contingency (10%) = | $ 7,300.00 | $ 16,000.00 |
| **Total Project Cost =** | **$ 80,300.00** | **$ 176,500.00** |

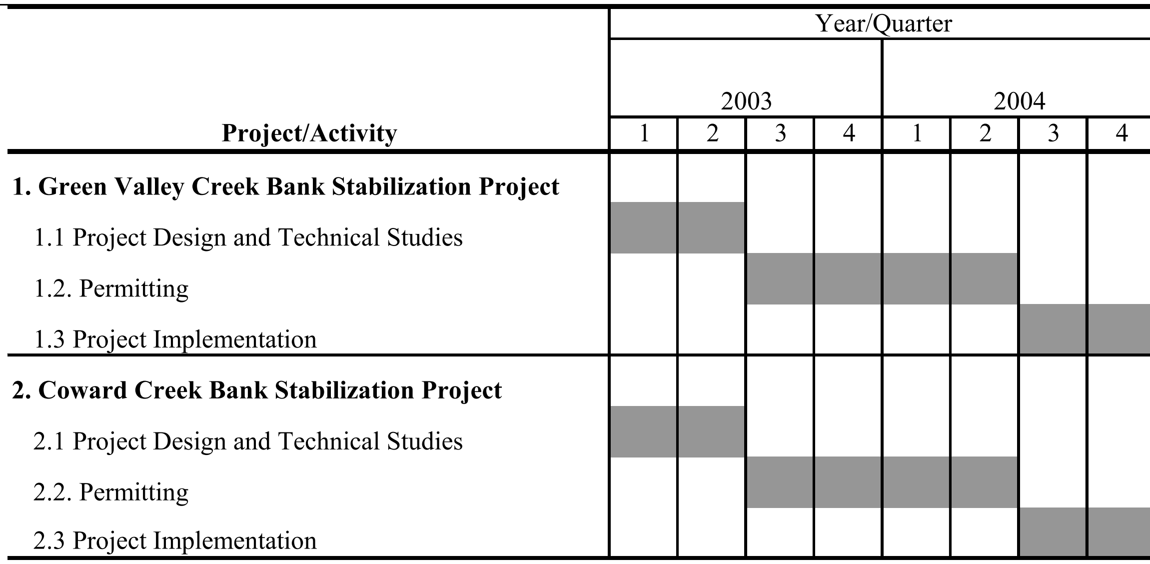


Figure 9.1 Project Timeline for Green Valley and Coward Creeks Bank Stabilization Projects

### 9.1.2. Upper College Lake Restoration Project

Four alternative restoration projects have been developed for the 50-acre Upper College Lake area, as described in Section 7.4.4. The first alternative project would include a multi-use facility creating approximately 40-acres of freshwater wetlands and restoring approximately 2,000 lineal feet of stream channel, a water storage basin and several miles of recreational trails. The second alternative presents a smaller wetland (~18-acres) and stream restoration project that would potentially provide off-site mitigate credit for future water supply projects undertaken by the PVWMA. The third alternative presents a large wetland and stream enhancement project designed to maximize wildlife habitat, while limiting public access. The last alternative is designed to create a large wetland habitat area (~45-acres), also designed to maximize wildlife habitat. Table 9.2 presents a preliminary cost estimate for these restoration projects.

Recognizing that the proposed restoration plans presented in this report are conceptual plans only, further planning and analysis would be require to evaluate the feasibility of these projects. Based on the results of feasibility study a preferred alternative would be selected. Therefore, as the initial task, a comprehensive feasibility should be carried out to evaluate the proposed projects. As previously discussed in Section Seven, the planning and feasibility study should be conducted that includes a thorough analysis of project constraints related to:

- Environmental (Biotic and Cultural) resources;
- Future projects;
- Project costs and funding;
- Permitting;
- Engineering/design; and
- Long-term management.

Table 9.2 presents a preliminary cost estimate to conduct a project feasibility study. To carryout this project the PVWMA will need to obtain funding. Potential funding sources may be available through the NRCS's Wildlife Habitat Incentives Program, the California Coastal Conservancy, California Department of Fish and Game and other sources. To apply for assistance from any of these agencies will take time, which will affect the timeline of the project. Figure 9.2 presents a proposed timeline for fund raising and project analysis.

Table 9.2 Preliminary Cost Estimates for Feasibility Study
For Upper College Lake Restoration

| Description | Total Cost |
|---|---|
| **Planning and Feasibility Analysis** | |
| a. Environmental Review | $ 35,000.00 |
| b. Evaluation of Project Alternative and Constraints | $ 10,000.00 |
| c. Pre- and Post Construction Project Management | $ 5,000.00 |
| d. Preliminary Engineering Analysis | $ 8,000.00 |
| e. Economic Analysis (cost estimation and funding source analysis) | $ 7,000.00 |
| Total | $ 65,000.00 |

| | Year/Quarter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | | | | 2004 | | | |
| **Activity** | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 1. Project Fund Raising | X | X | X | | | | | |
| 2. Planning and Feasibility Analysis | | | | X | X | X | | |

Figure 9.2 Proposed Timeline for Upper College Lake Feasibility Study

## 9.2. Drainage Master Planning

Drainage infrastructure (culverts) and waterways throughout the study area are aged and under capacity. This is resulting in substantial erosion around culverts and bank instability in steam and waterways. As previously recommended drainage master planning should be carried under the direction of the PSDMD and a landowner steering committee(s). Based on the drainage and land use characteristics of the watershed areas, FCE recommends dividing the area into three sub areas for study, including the Green Valley and Casserly Creek watersheds, the Hughs and Tynan Creek watersheds and the Coward and Thompson Creek Watersheds. The drainage studies should include the following elements:

1. A field assessment of existing drainage infrastructure and identification of key problem areas

2. Technical and financial analysis of alternative drainage improvement measures
   - Hydrologic and Hydraulic Analysis of problem areas
   - Identification of Alternative Improvement Projects
   - Benefit-cost analysis of alternative improvements

3. Selection of Proposed improvement projects

4. Preparation of Drainage Master Plan

5. Conduct/attend public meetings

Through a public review process the results of the drainage study(s) should be presented to joint committee of interested landowners and PSDMD staff to prioritize and select drainage improvement projects.

Table 9.3 presents a preliminary cost estimate for conducting drainage master plans in each subarea described.

Table 9.3 Preliminary Cost Estimate for Drainage Master Planning

| **Project** | **Green Valley and Casserly Creek Watersheds** | **Hughs and Tynan Creeks** | **Coward and Thompson Creeks** |
|---|---|---|---|
| Activity | Total Cost | | |
| **1. Field Assessment of Existing Drainage Infrastructure** | $ 45,000.00 | $ 35,000.00 | $ 35,000.00 |
| **2. Technical and Financial Analysis** | | | |
| 2.1. Hydrologic and Hydraulic Analysis | $ 20,000.00 | $ 15,000.00 | $ 20,000.00 |
| 2.2. Identification of Alternative Improvement Projects | $ 8,000.00 | $ 7,000.00 | $ 6,000.00 |
| 2.3. Benefit-Cost Analysis of Alternatives | $ 7,500.00 | $ 6,000.00 | $ 6,000.00 |
| **3. Selection of Proposed Improvements** | $ 5,000.00 | $ 4,000.00 | $ 4,000.00 |
| **4. Preparation of Drainage Master Plan** | $ 25,000.00 | $ 20,000.00 | $ 2,000.00 |
| **5. Public Meetings and Review** | $ 5,000.00 | $ 5,000.00 | $ 5,000.00 |
| **Total Estimated Study Costs** | **$ 115,500.00** | **$ 92,000.00** | **$ 78,000.00** |

## 9.3. Technical Workshops

A series of technical training sessions are recommended to address erosion control on agricultural lands. Through the collaborative efforts of the RCD, NRCS, UCCE and private consultants a series of workshops could be conducted that cover the following topics, as described in Section Eight:

1. **On-farm Drainage Management.** A short course on basic concepts of rainfall-runoff estimation, common drainage problems, overview of drainage best management practices, cost, selection and design of drainage BMPS; and, lastly, timing and installation BMPs.

2. **Funding (Cost-Share) Opportunities.** The RCD and NRCS should conduct a series of workshop(s) to inform private landowners of funding programs currently available.

3. **Biotechnical Bank Stabilization Practices.** A workshop for landowners or managers to introduce the concept of biotechnical bank stabilization methods is recommended. An important aspect of a workshop should be to stress the importance of maintaining adequate setbacks between fields and waterways and the use of vegetation to provide for long-term stabilization of stream channels.

Table 9.4 presents a preliminary cost estimate for conducting a series of three workshops.

Table 9.4 Preliminary Cost Estimate for Erosion Control Technical Workshops

| | Workshop | | |
|---|---|---|---|
| | On-farm Drainage Management | Funding (Cost-Share Opportunities) | Biotechnical Bank Stabilization Practices |
| **Personnel** | Total Cost | | |
| RCD Watershed Coordinator | $ 1,300.00 | $ 1,000.00 | $ 1,000.00 |
| NRCS Soil Conservationist | $ 1,500.00 | $ 1,500.00 | $ 1,500.00 |
| Soil Scientist | $ 1,500.00 | -- | -- |
| Civil Engineer/Erosion Control Specialist | $ 1,500.00 | -- | $ 2,200.00 |
| Expenses | $ 500.00 | $ 200.00 | $ 500.00 |
| **Total Estimated Study Costs** | **$ 6,300.00** | **$ 2,700.00** | **$ 5,200.00** |